WORKSHOP RECEIPTS,

FOR THE USE OF

MANUFACTURERS, MECHANICS, AND SCIENTIFIC AMATEURS.

BY

ERNEST SPON.

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PREFACE.

WORKSHOP RECEIPTS was compiled to effect three purposes; to serve as a note-book for the small manufacturer; to supply the intelligent workman with information required to conduct a process, foreign perhaps to his habitual labour, but which it is necessary to practise at the time; and impart to the scientific amateur a knowledge of many processes in the arts, trades, and manufactures, which will, it is hoped, render his pursuits the more instructive and remunerating.

The novice would do well to remember that it is the individual skill of the workman in performing many apparently simple operations which renders those operations successful, and that this skill is only obtained from long practice or natural ability. A pre-eminently superior manipulator resembles a poet in that he is 'born, not made;' when therefore a receipt is tried for the first time and is not thoroughly successful, the experimentalist should consider how far his own inexperience has contributed to the failure ere he condemns the receipt.

Receipts peculiarly useful to Mechanical Draughtsmen are given at pages 1 to 9. Receipts for Alloys, Casting, and Founding, pp. 9 to 13; Bronzes and Bronzing, pp. 16 to 21; Cements, pp. 22 to 25; Dyeing, pp. 30 to 40; Glass-cutting, twisting, drilling, darkening, bending, staining, and painting, pp. 55 to 60; Pottery and Porcelain, pp. 42 to 52; Glass, pp. 53 to 60; Varnishes, Japans, and Polishes, pp. 60 to 88; Pigments, and Painting in Oils, in Water Colours, as well as Fresco, House, Transparency, Sign, and Carriage Painting, pp. 89 to 116; Lathing and Plastering, pp. 120 to 123; Paper-hanging, pp. 118, 119; Firework Making, pp. 125 to 146; Engraving and Etching, pp. 146 to 170; Electro-Metallurgy, including Cleaning, Dipping, Scratchbrushing, Batteries, Baths,

and Deposits of every description, pp. 170 to 246; Photography, pp. 246 to 295; Inks, pp. 343 to 349; Silvering, pp. 206 and 335; Gilding, pp. 188 to 199; Solders, p. 364; Soap, pp. 372 to 386; Candles, p. 350; Veneering, pp. 411 to 414; Marble Working, pp. 386 to 393; Dyeing, Graining, and Staining Wood, pp. 414 to 426; interspersed with other matters far too numerous to mention.

As far as possible subjects at all allied in character, either in constitution or mode of working, have been grouped together; and in general, the main subject is indicated by a heading in bold clarendon type, branch-subjects by small capitals, and details by italics. The difficulty, however, of obtaining certain information just when it was wanted, has prevented the adoption of anything like an alphabetical or other concatenated arrangement of the subject matter; it is believed that no inconvenience will arise from this cause, as the index is very comprehensive.

Care has been exercised in cases where the practical operation connected with a receipt has been apart from the writer's experience, to have it verified by authority, and the aim throughout has been to render 'Workshop Receipts' a reliable handbook for all interested in Technological pursuits.

ERNEST SPON.

August 1, 1873.

WORKSHOP RECEIPTS.

Drawing Paper.—The following table contains the dimensions of every description of English drawing-paper.

	inches.		inches.
Demy	20	by	15
Medium	22	"	17
Royal	24	"	19
Imperial	31	"	21
Elephant	27	"	23
Columbier	34	"	23
Atlas	33	"	26
Double Elephant	40	"	26
Antiquarian	52	"	29
Emperor	68	"	48

For making detail drawings an inferior paper is used, termed Cartridge; this answers for line drawings, but it will not take colours or tints perfectly. Continuous cartridge paper is also much used for full-sized mechanical details, and some other purposes. It is made uniformly 53 inches wide, and may be had of any length by the yard, up to 300 yards.

For plans of considerable size, mounted paper is used, or the drawings are afterwards occasionally mounted on canvas or linen.

Mounting Drawings or Paper on Linen.—The linen or calico is first stretched by tacking it tightly on a frame or board. It is then thoroughly coated with strong size, and left until nearly dry. The sheet of paper to be mounted requires to be well covered with paste; this will be best if done twice, leaving the first coat about ten minutes to soak into the paper. After applying the second coat, place the paper on the linen and dab it all over with a clean cloth. Cut off when thoroughly dry.

To Fasten Paper on a Drawing Board.—The stretched irregular edges of the sheet of paper are cut off against a flat ruler, squaring it at the same time. The sheet of paper is laid upon the board the *reverse* side upwards to that upon which the drawing is to be made. It is then damped over, first by passing a moist clean sponge, or wide brush, round the *edges* of the paper about an inch and a half on, and afterwards thoroughly damping the whole surface, except the edges. Other plans of damping answer equally well; it is only necessary to observe that the edges of the paper should not be quite so damp as the other part of the surface. After the paper is thoroughly damped, it is left until the wet gloss entirely disappears; it is then turned over and put in its position on the board. About half an inch of the edge of the paper is then turned up against a flat ruler, and a glue-brush with hot glue passed between the turned-up edge and the board; the ruler is then drawn over the glued edge and pressed along. If upon removing the ruler the paper is found not to be thoroughly close, a paper-knife or similar article passed over it will secure perfect contact. The next *adjoining edge* must be treated in like manner, and so on each consecutive edge, until all be secured. The contraction of the paper in drying should leave the surface quite flat and solid.

Cutting Pencils.—If the point is intended for sketching, it is cut equally from all sides, to produce a perfectly acute cone. If this be used for line drawing, the tip will be easily broken, or otherwise it soon wears thick; thus, it is much better for line drawing to have a thin flat point. The general manner of proceeding is, first, to cut the pencil, from two sides only, with a long slope, so as to produce a kind of chisel-end, and afterwards to cut the other sides away only sufficient to be able to round the first edge a little. A point cut in the manner described may be kept in good order for some time by pointing the lead upon a small piece of fine sandstone or fine glass-paper; this will be less trouble than the continual

application of the knife, which is always liable to break the extreme edge.

Erasing Errors.—To erase Cumberland-lead pencil marks, native or bottle india-rubber answers perfectly. This, however, will not entirely erase any kind of German or other manufactured pencil marks. What is found best for this purpose is fire vulcanized india-rubber; this, besides being a more powerful eraser, has also the quality of keeping clean, as it frets away with the friction of rubbing, and presents a continually renewed surface to the drawing; the worn-off particles produce a kind of dust, easily swept away. Vulcanized rubber is also extremely useful for cleaning off drawings, as it will remove any ordinary stain.

For erasing ink lines, the point of a penknife or erasing knife is commonly used. A much better means is to employ a piece of fine glass-paper, folded several times, until it presents a round edge; this leaves the surface of the paper in much better order to draw upon than it is left from knife erasures. Fine size applied with a brush will be found convenient to prevent colour running.

To produce finished drawings, it is necessary that no portion should be erased, otherwise the colour applied will be unequal in tone; thus, when highly-finished mechanical drawings are required, it is usual to draw an original and to copy it, as mistakes are almost certain to occur in delineating any new machine. Where sufficient time cannot be given to draw and copy, a very good way is to take the surface off the paper with fine glass-paper before commencing the drawing; if this be done, the colour will flow equally over any erasure it may be necessary to make afterwards.

Where ink lines are a little over the intended mark, and it is difficult to erase them without disfiguring other portions of the drawing, a little Chinese white or flake-white, mixed rather dry, may be applied with a fine sable-brush; this will render a small defect much less perceptible than by erasure.

Whenever the surface of the paper is roughened by using the erasing knife, it should be rubbed down with some hard and perfectly clean rounded instrument.

Buying Drawing Instruments.—Persons with limited means will find it better to procure good instruments separately of any respectable maker, W. Stanley of Holborn for instance, as they may be able to afford them, than to purchase a complete set of *inferior* instruments in a case. With an idea of economy, some will purchase second-hand instruments, which generally leads to disappointment, from the fact that inferior instruments are manufactured upon a large scale purposely to be sold as second-hand to purchasers, principally from the country, who are frequently both unacquainted with the workmanship of the instruments and of the system practised.

Inferior instruments will never wear satisfactorily, whereas those well made improve by use, and attain a peculiar working smoothness. The extra cost of purchasing the case and the nearly useless rules, would, in many instances, be equal to the difference between a good and an inferior set of instruments without the case. Instruments may be carefully preserved by merely rolling them up in a piece of wash leather, leaving space between them that they may not rub each other; or, what is better, having some loops sewn on the leather to slip each instrument separately under.

Drawing Board.—The qualities a good drawing board should possess are, an equal surface, which should be slightly rounded from the edges to the centre, in order that the drawing paper when stretched upon it may present a solid surface; and that the edges should be perfectly straight, and at right angles to each other.

In Using a Drawing Pen, it should be held very nearly upright, between the thumb and first and second fingers, the knuckles being bent, so that it may be held at right angles with the length of the hand. The

handle should incline only a very little—say ten degrees. No ink should be used except indian ink, rubbed up fresh every day upon a clean palette. Liquid ink and other similar preparations are generally failures. The ink should be moderately thick, so that the pen when slightly shaken will retain it a fifth of an inch up the nibs. The pen is supplied by breathing between the nibs before immersion in the ink, or by means of a small camel-hair brush; the nibs will afterwards require to be wiped, to prevent the ink going upon the edge of the instrument to be drawn against. The edge used to direct the pen should in no instance be of less than a sixteenth of an inch in thickness; a fourteenth of an inch is perhaps the best. If the edge be very thin, it is almost impossible to prevent the ink escaping upon it, with the great risk of its getting on to the drawing. Before putting the pen away, it should be carefully wiped between the nibs by drawing a piece of folded paper through them until they are dry and clean.

To Test the Accuracy of a Straight-edge.—Lay the straight-edge upon a stretched sheet of paper, placing weights upon it to hold it firmly; then draw a line against the edge with a needle in a holder, or a very fine hard pencil, held constantly vertical, or at one angle to the paper, being careful to use as slight pressure as possible. If the straight-edge be then turned over to the reverse side of the line, and a second line be produced in a similar manner to the first at about the twentieth of an inch distance from it, any inequalities in the edge will appear by the differences of the distances in various parts of the lines, which may be measured by spring dividers.

Another method will be found to answer well if three straight-edges are at hand; this method is used in making the straight-edge. Two straight-edges are laid together upon a flat surface, and the meeting edges examined to see if they touch in all parts, reversing them in every possible way. If these two appear perfect, a third straight-edge is applied to each of the edges already tested, and if that touch it in all parts the edges are all perfect. It may be observed that the first two examined, although they touch perfectly, may be regular curves; but if so, the third edge applied will detect the curvature.

In Using the Plain Parallel Rule, one of the rules is pressed down firmly with the fingers, while the other is moved by the centre stud to the distances at which parallel lines are required. Should the bars not extend a sufficient distance for a required parallel line, one rule is held firmly, and the other shifted, alternately, until the distance is reached.

Using Dividers or Compasses.—It is considered best to place the forefinger upon the head, and to move the legs with the second finger and thumb. In dividing distances into equal parts, it is best to hold the dividers as much as possible by the head joint, after they are set to the required dimensions; as by touching the legs they are liable to change, if the joint moves softly as it should. In dividing a line, it is better to move the dividers alternately above and below the line from each point of division, than to roll them over continually in one direction, as it saves the shifting of the fingers on the head of the dividers. In taking off distances with dividers, it is always better, first to open them a little too wide, and afterwards close them to the point required, than set them by opening.

Pencilling.—If a drawing could be at once placed to the best advantage on the paper, and surely made without mistake and with all its lines correctly limited when first drawn, it might be made in ink directly on the blank paper. To avoid the errors inevitable in the first copy of any production, even when made by those most practised, drawings are first pencilled and then inked. The whole theory of pencilling, then, is, to lay out correct *tracks* on which the pen is to move, leaving the

mind, during the inking, free from all thought of *accuracy* of the *construction*, that it may be given to *excellence* in *execution*. Therefore, the whole of the pencil-construction should be *most accurately* made in the *finest faint* lines with a hard pencil.

Finishing a Drawing.—While "Finish a drawing without any error or defect," should be the draughtsman's best motto, he should never be in haste to reject a damaged drawing, but should exercise his ingenuity to see how far injuries done to it may be remedied. "Never lose a drawing once begun," should be his second motto; and since prevention is easier and better than cure, let him always work calmly, inspect all instruments, hands, and sleeves, that may touch a drawing, before commencing an operation; let the paper, instruments, and person *be kept clean*, and when considerable time is to be spent upon a portion of the paper, let the remainder be covered with waste paper, pasted to one edge of the board.

For the final cleaning of the drawing, stale bread, or the old-fashioned black india-rubber, if not sticky, is good; but, aside from the carelessness of ever allowing a drawing to get very dirty, any fine drawing will be injured, more or less, by *any* means of removing a considerable quantity of dirt from it.

Another excellent means of preventing injuries, which should be adopted when the drawing is worked upon only at intervals, is to enclose the board, when not in use, in a bag of enamelled cloth or other fine material.

Lettering.—The title to a drawing should answer distinctly the four questions — *What*, *Who*, *Where*, and *When*—*What*, including the use and scale; *Who*, both as to designer or inventor, and draughtsman; *Where*, both as to the place, institution, or office where the drawing was made, and the locality of the object drawn; and *When*.

If the drawing is perfectly symmetrical, its title should have the same axis of symmetry as the drawing. If the drawing is unsymmetrical, the title may be at either of the lower corners.

These principles do not apply to horizontal views, as maps of surveys, where the title may be wherever the shape of the plot affords the best place.

One quite essential element of beauty in a title is its arrangement, or the *form of its outline* as a whole. It should embrace such variations in the length of its lines of letters that the curve formed by joining the extremities of those lines would be a simple and graceful one, having also a marked variety of form. Also the greatest length of the title should generally be horizontal; or its proportions, as a whole, like those of the border of the drawing.

When the occupation of the paper affords only narrow blank spaces lying lengthwise of the paper, the title looks well, mostly on a single line at the bottom, the principal words being in the middle, and the subordinate ones at the two sides.

Moreover, horizontal lines should prevail in the direction of the lines of words in the title. Indeed, the title may be arranged wholly on horizontal lines with good effect, though an arched or bow-shaped curve for the principal words may be adopted when the drawing includes some conspicuous arching lines.

The size of the title should be appropriate to that of the drawing. In particular, the rule has been proposed that the height of the largest letters in the title should not exceed three-hundredths of the shorter side of the border. Also, the relative size of the different portions of the title should correspond to their relative importance, the name of the object and its inventor being largest, and that of the draughtsman, his location, and the date of his work being considerably smaller.

Geometrical drawings are *most* appropriately lettered with geometrical letters, which, when neatly made, always look well. Any letters, however, having any kind of sharply-defined and precise form, as German text, are not inappropriate to a geometrical drawing; but vaguely formed "rustic" or other

free-hand letters are in bad taste on such drawings.

Letters should correspond in conspicuousness or body of colour with the rest of the drawing, not being obtrusive from great heaviness of solid black outline, or unobservable from excessive faintness. Also, violent contrasts of heaviness among neighbouring portions of the title should be avoided; though there may be a gradual change, both of intensity and size, from the most to the least important words of the title.

This should, first of all, not exceed in elaborateness the draughtsman's ability to execute it with perfect neatness and clearness. Then it should agree with the character of the drawing. Plain and simple letters look best on a similar drawing, while a complicated and highly-finished drawing may receive letters of more ornamental character.

Borders.—For line drawings the border should be a geometrical design, in lines, with curved or angular corners, or with combinations of straight or curved lines, forming geometrical corner-pieces. These borders may vary in complexity from a rectangular border in single lines to borders which, though geometrical, may be elaborate and elegant. Thus: a plate of varieties of straight horizontal lines may have a plain rectangular border; one including oblique lines may include oblique lines in the border, either as a little tuft in each corner, a truncated corner, or a square set diagonally, &c. Plates embracing curve lines may have quarter-circle borders, either convex or concave inwards—of which the former have most decision. Such plates may also have little circles for corner-pieces. Borders may sometimes conform in a pleasing manner to the general outline of a drawing. Thus, an arched bridge may have a semi-oval upper border and a square-cornered border at the base of the drawing; and an ornamental device may crown the summit of the border.

When the drawing is a shaded one, containing, therefore, some free-hand work, the border may be partly free-hand also; but should still be largely geometrical in its design, and should represent a real border of substantial materials, corresponding to the subject of the drawing. Thus, the mouldings and ornaments should represent ornamental metallic castings, carvings in wood, mouldings in plaster, or scrolls and leaves of rolled metal; but garlands, tassels, and tendrils, &c., should not be introduced.

The border to a geometrical drawing should be like the drawing itself in being executed with the drawing pen and brush, as well as with the mapping pen. Free-hand pen borders, representing the products of the soil, with cornucopias, little pen sketches of scenery, or similar agricultural or landscape devices, worked in as corner-pieces, are more appropriate on topographical drawings.

As to colour, *primary* colours should not be largely introduced into the border; *first*, since they, when obtrusive, are adapted to ruder or less impressible tastes than the secondary hues, shades, and tints, which are more gratifying to delicate tastes; and *secondly*, from the impertinent conspicuousness which they may give to the border.

Drawings which are shaded only in sepia or ink, or any dark neutral tint, may have the border done in the same, or in a dark complementary colour. Tinted ink drawings are best finished with a plain ink border.

Indian Ink is used for producing the finished lines of all kinds of geometrical drawing. Being free from acid, it does not injure or corrode the steel points of the instruments. The genuine ink, as it is imported from China, varies considerably in quality; that which answers best for line drawing will wash up the least when other colours are passed over it. This quality is ascertained in the trade, but not with perfect certainty, by breaking off a small portion. If it be of the right quality it will show, when broken, a very bright and almost prismatic-coloured fracture. Indian ink should be used immediately after it is mixed; if re-dissolved it becomes cloudy and irregular in tone,

but with every care, it will still wash up more or less.

Colours.—For colouring drawings, the most soluble, brilliant, and transparent water-colours are used; this particularly applies to plans and sections. The colour is not so much intended to represent that of the material to be used in the construction, as to clearly distinguish one material from another employed on the same work.

The following table shows the colours most employed by the profession:—

Carmine or Crimson Lake	For brickwork in plan or section to be executed.
Prussian Blue	Flintwork, lead, or parts of brickwork to be removed by alterations.
Venetian Red	Brickwork in elevation.
Violet Carmine	Granite.
Raw Sienna	English timber (not oak).
Burnt Sienna	Oak, teak.
Indian Yellow	Fir timber.
Indian Red	Mahogany.
Sepia	Concrete works, stone.
Burnt Umber	Clay, earth.
Payne's Grey	Cast iron, rough wrought iron.
Dark Cadmium	Gun metal.
Gamboge	Brass.
Indigo	Wrought iron (bright).
Indigo, with a little Lake	Steel (bright).
Hooker's Green	Meadow land
Cobalt Blue	Sky effects.

And some few others occasionally for special purposes.

In colouring plans of estates, the colours that appear natural are mostly adopted, which may be produced by combining the above. Elevations and perspective drawings are also represented in natural colours, the primitive colours being mixed and varied by the judgment of the draughtsman, who, to produce the best effects, must be in some degree an artist.

Care should be taken in making an elaborate drawing, which is to receive colour, that the hand at no time rest upon the surface of the paper, as it is found to leave a greasiness difficult to remove. A piece of paper placed under the hand, and if the square is not very clean, under that also, will prevent this. Should the colours, from any cause, work greasily, a little prepared ox-gall may be dissolved in the water with which the colours are mixed, and will cause them to work freely.

Shading.—For shading, camel or sable hair brushes, called Softeners, are generally used: these have a brush at each end of the handle, one being much larger than the other. The manner of using the softener for shading is, to fill the smaller brush with colour, and to thoroughly moisten the larger one with water; the colour is then laid upon the drawing with the smaller brush, to represent the dark portion of the shade, and immediately after, while the colour is quite moist, the brush that is moistened with water is drawn down the edge intended to be shaded off; this brush is then wiped upon a cloth and drawn down the outer moist edge to remove the surplus water, which will leave the shade perfectly soft.

If very dark shades are required, this has to be repeated when the first is quite dry.

To tint large surfaces, a large camel-hair brush is used, termed a Wash-brush. The manner of proceeding is, first, to tilt the drawing, if practicable, and commence by putting the colour on from the upper left-hand corner of the surface, taking short strokes the width of the brush along the top edge of the space to be coloured, immediately following with another line of similar strokes into the moist edge of the first line, and so on as far as required, removing the last surplus colour with a nearly dry brush. The theory of the above is, that you may perfectly unite wet colour to a moist edge, although you cannot to a dry edge without showing the juncture. For tinting surfaces, it is well always to mix more than sufficient colour at first.

Colouring Tracings.—It is always best to colour tracings on the back, as the ink lines are liable to be obliterated when the colour is applied. Mix the colours very dark, so that they may appear of proper depth on the other side. If ink or colour does not run freely on tracing cloth, mix both with a little ox-gall.

Cutting Stencil Plates.—The perforations are made through the metal, either by engraving, by etching with nitric acid diluted with about one-third water, or, what is better, by both methods combined. If engraving only is employed, the force necessarily applied to the graver will sometimes stretch the plate unequally, whereas by etching alone, the edges of the perforations are left rough, and the corners imperfect; but if the line be lightly etched, and afterwards cleared with the graver, it may be rendered perfect without any risk of cockling the plate. If the back of the plate is smeared with a little oil, the cuttings will come out clean. A good ground for the etching of these plates is made by rubbing on them, slightly heated over a spirit lamp, a cake of heel-ball.

Copper is much better than brass for stencil plates: the metal being softer, it lies closer to the paper upon receiving the pressure of the stencilling brush. This close contact is a very important consideration, as it prevents the hairs of the brush from getting under the plate, and producing rough edges.

Plain stencil alphabets will not be necessary to a draughtsman, if he is a good writer, as they will only save him a little time. A greater saving may be effected by the use of words which are constantly recurring; as Ground plan, Front elevation, Section; or of interiors, as Drawing-room, Kitchen.

For railway or public works, headings of plans may be cut in suitable character and style; also words which are frequently repeated on any particular works, as the name and address of the architect or engineer.

Besides letters and words, there are many devices by the use of which a superior effect may be produced, and much time saved; of these may be mentioned, north points, plates for the representation of surface of country, as plantation, wood, or marsh, corners and borders for finished plans, and many other devices.

Using Stencil Plates.—The brush requires to be squarely and equally cut, and to be kept moderately clean. If indian ink is used, the largest surface of the cake should be taken to rub the moist brush upon, to get it equally diffused and softened with colour. A cheap kind of ink is sold with stencil plates, which answers better than indian ink, as it runs less upon the drawing and presents a larger surface to the brush.

After the plate has been in use some time, the fine lines and corners become clogged with ink, which may easily be removed by soaking the plate a short time in warm water, and afterwards lightly brushing it upon a flat surface until quite clean. It must be particularly observed that a cloth should at no time be applied to the plate either to clean or to wipe it, as this would be almost certain to catch in some of the perforations, and probably spoil the plate.

If the plate by improper use becomes cockled, it may be flattened, if laid upon a hard flat surface, by drawing a cylindrical piece of metal, as, for instance, the plain part of the stem of a poker, firmly across it several times on each side of the plate.

In using the stencil plate, hold it firmly to the drawing by *one edge* only, in no instance allowing the fingers to cross to the opposite edge. The general method is, to place the fingers of the left hand along the bottom edge. When the brush is diffused with ink, so that it is just moist, lightly brush it upon a book-cover or pad, so as to free the points from any excess of colour. In applying the brush to the plate, it should be held quite upright, and moved, not too quickly, in small circles, using a constant, equal pressure, as light as appears necessary. The stencilling should be commenced at one end of the plate and proceeded with gradually to the other, moving onwards as the perforations appear filled with colour, being particularly careful not to shift the fingers placed upon the plate during the operation. If the plate is very long, after each word the fingers may be shifted, if the plate be held down during

the time firmly by the other hand. Should there not be quite sufficient ink in the brush to complete the device, the plate may be breathed upon, which will moisten the ink attached to the plate. If, after the plate is removed, the device appears light in parts, the plate may be replaced and the defects remedied, if very great care be taken to observe that the previous stencilling perfectly covers the perforations.

In stencilling words or numbers with the separate letters of the alphabet, draw a line where the bottoms of the letters are intended to come, take the separate letters as required and place them upon the line, so that the line just appears in the perforations. That the letters may be upright, it is best that the next letter on the slip used should also allow the line to appear in it. The required distance of the letters apart must be judged of by the eye, a pencil mark being made, after each letter is completed, to appear in the perforation on the near side of the next letter to be stencilled.

With care, a stencil plate will last in constant use for many years; without care, it is practically spoilt by taking the first impression.

Removing Drawings from the Board.—Make a pencil line round the paper with the tee-square at a sufficient distance to clear the glued edge, and to cut the paper with a penknife, guided by a stout ruler. In no instance should the edge of the tee-square be used to cut by. A piece of hard wood, half an inch thick by two inches wide, and about the length of the paper, forms a useful rule for the purpose, and may be had at small cost. The instrument used for cutting off, in any important draughtsman's office, is what is termed a *stationer's rule,* which is a piece of hard wood of similar dimensions to that just described, but with the edges covered with brass. It is necessary to have the edge thick to prevent the point of the knife slipping over. Either of the above rules will also answer to turn the edge of the paper up against when glueing it to the board.

The Frame for a Drawing is to afford a suitable protection to the finished drawing, and hence should be so subordinate in design and colour as not to distract attention from the drawing.

For geometrical drawings, a gilt frame is, in general, preferable to a dark-coloured wooden one. Occasionally the latter style of frame may be appropriate, as in case of a very darkly-shaded drawing on tinted paper, or of a drawing which very completely fills the paper.

It hardly need be said that a frame of plain mouldings is more appropriate for a geometrical drawing than is a carved or stucco-moulded frame. For ordinary geometrical drawings, nothing is prettier than an Oxford frame of light oak, or a plain gold frame.

Vegetable Parchment is made by dipping ordinary paper, for a few seconds, into a solution, containing one part water to six sulphuric acid; then washing it carefully, to remove every trace of acid.

Indelible Pencil Writing.—Lay the writing in a shallow dish, and pour skimmed milk upon it. Any spots not wet at first may have the milk placed upon them lightly with a feather. When the paper is wet all over, with the milk, take it up and let the milk drain off, and remove with the feather the drops which collect on the lower edge. Dry carefully.

Pencil Drawings, To fix.—Prepare water-starch, in the manner of the laundress, of such a strength as to form a jelly when cold, and then apply with a broad camel-hair brush, as in varnishing. The same may be done with thin, cold isinglass water or size, or rice water.

Mounting Engravings.—Strain thin calico on a frame, then carefully paste on the engraving so as to be free from creases; afterwards, when dry, give two coats of thin size (a piece the size of a small nut in a small cupful of hot water will be strong enough), finally, when dry, varnish with white hard varnish.

To Renew Manuscripts.—Take a hair pencil and wash the part that has been effaced with a solution of prussiate of potash in water, and the writing will again appear if the paper has not been destroyed.

Uniting Parchment to Paper, or Wood.—The surface of the parchment must first be moistened with alcohol or brandy and pressed while still moist upon glue or paste. When two pieces of parchment are to be joined, both must be moistened in this way. It is said that the paper will sooner tear than separate where it has been thus fastened together. Another way is to put a thin piece of paper between the surfaces of parchment and apply the paste. This forms a firm joint, and can with difficulty be separated. Glue and flour paste are best adapted for uniting surfaces of parchment.

Tracing Paper.—1. Wash very thin paper with a mixture of: Spirits of turpentine, 6; Resin, 1; Boiled nut oil, 1, parts by weight, applied with a soft sponge.

2. Brushing over one side of a good, thin, unsized paper with a varnish made of equal parts of Canada balsam and turpentine. If required to take water colour, it must be washed over with ox-gall and dried before being used.

3. Open a quire of double-crown tissue paper, and brush the first sheet with a mixture of mastic varnish and oil of turpentine, equal parts; proceed with each sheet similarly, and dry them on lines by hanging them up singly. As the process goes on, the under sheets absorb a portion of the varnish, and require less than if single sheets were brushed separately.

Transfer Paper is made by rubbing white paper with a composition consisting of 2 oz. of tallow, ½ oz. powdered black-lead, ¼ pint of linseed oil, and sufficient lampblack to make it of the consistency of cream. These should be melted together and rubbed on the paper whilst hot. When dry it will be fit for use.

Babbitt's Attrition Metal.—Preparing and fitting, melt separately 4 lbs. of copper, 12 lbs. best quality Banca tin, 8 lbs. regulus of antimony, and 12 lbs. more of tin while the composition is in a melted state. Pour the antimony into the tin, then mix with the copper away from the fire in a separate pot.

In melting the composition, it is better to keep a small quantity of powdered charcoal on the surface of the metal. The above composition is called "hardening." For lining the boxes, take 1 lb. of hardening and melt it with 2 lbs. of Banca tin, which produces the lining metal for use. Thus the proportions for lining metal are, 4 lbs. of copper, 8 lbs. of regulus of antimony, and 96 lbs. of Banca tin.

The article to be lined, having been cast with a recess for the lining, is to be nicely fitted to a former, which is made of the same shape as the bearing. Drill a hole in the article for the reception of the metal, say a half or three-quarters of an inch, according to the size of it. Coat over the part not to be tinned with a clay wash, wet the part to be tinned with alcohol, and sprinkle on it powdered sal-ammoniac; heat it till a fume arises from the sal-ammoniac, and then immerse in melted Banca tin, taking care not to heat it so that it will oxidize. After the article is tinned, should it have a dark colour, sprinkle a little sal-ammoniac on it, which will make it a bright silver colour. Cool it gradually in water, then take the former, to which the article has been fitted, and coat it over with a thin clay wash, and warm it so that it will be perfectly dry; heat the article until the tin begins to melt, lay it on the former and pour in the metal, which should not be so hot as to oxidize, through the drilled hole, giving it a head, so that as it shrinks it will fill up. After it has sufficiently cooled remove the former.

A shorter method may be adopted when the work is light enough to handle quickly; namely when the article is prepared for tinning, it may be immersed in the lining metal instead of the tin, brushed lightly in order to

remove the sal-ammoniac from the surface, placed immediately on the former and lined at the same heating.

Blanched Copper.—Fuse 8 oz. of copper and ½ oz. of neutral arsenical salt, with a flux made of calcined borax, charcoal dust, and powdered glass.

Yellow Brass.—30 parts of zinc and 70 of copper in small pieces.

YELLOW BRASS, *for Turning*.—(*Common article*.)—Copper, 20 lbs.; zinc, 10 lbs.; lead from 1 to 5 oz. Put in the lead last before pouring off.

Red Brass, *for Turning*.—Copper, 24 lbs.; zinc, 5 lbs.; lead, 8 oz. Put in the lead last before pouring off.

RED BRASS, *free, for Turning*.—Copper, 160 lbs.; zinc, 50 lbs.; lead, 10 lbs.; antimony, 44 oz.

Another Brass, *for Turning*.—Copper, 32 lbs.; zinc, 10 lbs.; lead, 1 lb.

Best Red Brass, *for fine Castings*.—Copper, 24 lbs.; zinc, 5 lbs.; bismuth, 1 oz. Put in the bismuth last before pouring off.

Rolled Brass.—32 copper, 10 zinc, 1·5 tin.

Common Brass, *for Castings*.—20 copper, 1·25 zinc, 2·5 tin.

Hard Brass, *for Casting*.—25 parts copper, 2 zinc, 4·5 tin.

Brass Melting.—The best plan of smelting brass is to melt the copper in a black-lead crucible first, *dry* and *cool* the zinc as much as possible and immerse the whole of the zinc into the copper when the latter is not hotter than barely to continue fluid. Drop a piece of borax the size of a walnut into the pot. When the surface of the hot metal is covered by fine charcoal, or borax, which is prevented by renewal from burning, the smallest loss of zinc is sustained.

The melting together of tin and copper is less difficult than that of zinc and copper, because tin is not so liable to evaporate as zinc, and little metal is lost. The appearance of the alloy may be improved by covering the melted metal with about one per cent. of dried potash; or, better still, a mixture of potash and soda. This flux has a remarkable influence on the colour, and particularly on the tenacity of the alloy. The former becomes more red, and the latter stronger. The scum forming on the surface by this addition ought to be removed before the metal is cast. Tin and copper are liable to separation in cooling; this can be prevented, at least partly, by turning the mould containing the fluid metal, and keeping it in motion until it is chilled.

Copper and lead unite only to a certain extent: 3 lead and 8 copper is ordinary pot metal. All the lead may be retained in this alloy, provided the object to be cast is not too thick. When the cast is heavy, or much lead is used, it is pressed out by the copper in cooling. 1 lead, 2 copper, separates lead in cooling—it oozes out from the pores of the metal: 8 copper and 1 lead is ductile, more lead renders copper brittle. Between 8 to 1 and 2 to 1 is the limit of copper and lead alloys. All of these alloys are brittle when hot or merely warm.

Equal parts of copper and silver and 2 per cent. of arsenic form an alloy similar to silver, a little harder, however, but of almost equal tenacity and malleability. Antimony imparts a peculiar beautiful red colour to copper, varying from rose-red in a little copper and much antimony, to crimson or violet when equal parts of both metals are melted together.

Hardening for Britannia.—(*To be mixed separately from the other ingredients*.)—Copper, 2 lbs.; tin, 1 lb.

Good Britannia Metal.—Tin, 150 lbs.; copper, 3 lbs.; antimony, 10 lbs.

Britannia Metal, *2nd quality*.—Tin, 140 lbs.; copper, 3 lbs.; antimony, 9 lbs.

BRITANNIA METAL, *for Casting*.—Tin, 210 lbs.; copper, 4 lbs.; antimony, 12 lbs.

BRITANNIA METAL, *for Spinning*.—Tin, 100 lbs.; Britannia hardening, 4 lbs.; antimony, 4 lbs.

BRITANNIA METAL, *for Registers*.—Tin, 100 lbs.; hardening, 8 lbs.; antimony, 8 lbs.

Best Britannia, *for Spouts.*—Tin, 140 lbs.; copper, 3 lbs.; antimony, 6 lbs.

Best Britannia, *for Spoons.*—Tin, 100 lbs.; hardening, 5 lbs.; antimony, 10 lbs.

Best Britannia, *for Handles.*—Tin, 140 lbs.; copper, 2 lbs.; antimony, 5 lbs.

Best Britannia, *for Lamps, Pillars, and Spouts.*—Tin, 300 lbs.; copper, 4 lbs.; antimony, 15 lbs.

Britannia, *for Casting.* — Tin, 100 lbs.; hardening, 5 lbs.; antimony, 5 lbs.

Lining Metal, *for Boxes of Railroad Cars.*—Mix tin, 24 lbs.; copper, 4 lbs.; antimony, 8 lbs. (for a hardening); then add tin, 72 lbs.

Bronze Metal. — (1.) Copper, 7 lbs.; zinc, 3 lbs.; tin, 2 lbs. (2.) Copper, 1 lb.; zinc, 12 lbs.; tin, 8 lbs.

Artificial Gold. — Pure copper, 100 parts; zinc, or preferably tin, 17 parts; magnesia, 6 parts; sal-ammoniac, 3·6 parts; quicklime, 1·8 part; tartar of commerce, 9 parts. The copper is first melted, then the magnesia, sal-ammoniac, lime, and tartar, are then added, separately and by degrees, in the form of powder; the whole is now briskly stirred for about half an hour, so as to mix thoroughly; and then the zinc is added in small grains by throwing it on the surface and stirring till it is entirely fused; the crucible is then covered, and the fusion maintained for about 35 minutes. The surface is then skimmed and the alloy is ready for casting. It has a fine grain, is malleable, and takes a splendid polish. Does not corrode readily, and for many purposes is an excellent substitute for gold. When tarnished, its brilliancy can be restored by a little acidulated water.

German Silver, *First Quality for Casting.*—Copper, 50 lbs.; zinc, 25 lbs.; nickel, 25 lbs.

German Silver, *Second Quality for Casting.*—Copper, 50 lbs.; zinc, 20 lbs.; nickel (best pulverized), 10 lbs.

German Silver, *for Rolling.*—Copper, 60 lbs.; zinc, 20 lbs.; nickel, 25 lbs. Used for spoons, forks, and table ware.

German Silver, *for Bells and other Castings.*—Copper, 60 lbs.; zinc, 20 lbs.; nickel, 20 lbs; lead, 3 lbs.; iron (that of tin plate being best), 2 lbs.

In melting the alloy for German silver it is difficult to combine a definite proportion of zinc with the compound of nickel and copper previously prepared. In fusing the three metals together there is always a loss of zinc by volatilization, which may be lessened by placing it beneath the copper in the crucible. The best method is to mix the copper and nickel, both in grains first, place them, thus mixed, in the crucible, when melted add the zinc and a piece of borax the size of a walnut. The zinc will gradually dissolve in the fluid copper, and the heat may be raised as their fluidity increases. In this instance, as in all others of forming alloys, it is profitable to mix the oxides of the various metals together, and reduce them under the protection of a suitable flux. The metal nickel can be produced only from pure oxide of nickel; and, as purity of the alloy is essential to good quality, the common commercial zinc is *not* sufficiently pure for forming argentan. Copper cannot well be used in the form of oxide, but grain copper or wire-scraps will serve equally as well.

Imitation of Silver. — Tin, 3 oz.; copper, 4 lbs.

Pinchbeck.—Copper, 5 lbs.; zinc, 1 lb.

Tombac.—Copper, 16 lbs.; tin, 1 lb.; zinc, 1 lb.

Red Tombac.—Copper, 10 lbs.; zinc, 1 lb.

Stereotype Metal.—1 tin; 1 antimony; 4 lead. In using stereotype metal, brush the type with plumbago or a small quantity of oil, then place in a frame, and take a cast with plaster of Paris. The cast is dried in a very hot oven, placed face downwards upon a flat plate of iron; this plate is laid in a tray or pan of iron, having a lid securely fastened, and furnished with a hole at each corner. Dip the tray in the fluid metal, which will flow in at the four corners. When the tray is re-

moved, dip the bottom only in water; and as the metal contracts in cooling, pour in melted metal at the corners so as to keep up the fluid pressure, and obtain a good solid cast. When cool open the tray; remove the cake of plaster and metal, and beat the edges with a mallet to remove superfluous metal. Plane the edges square, turn the back flat, in a lathe, to the required thickness, and remove any defects. If any letters are damaged cut them out, and solder in separate types instead. Finally, fix upon hard wood to the required height.

Casting Stereo-Plates by the Paper Process.—Lay a sheet of tissue paper upon a perfectly flat surface, and paste a soft piece of printing paper, which must be pressed evenly on, to the tissue. Lay the paper on the form, previously oiled, and cover with a damp rag; beat with a stiff brush the paper in evenly, then paste a piece of blotting paper, and repeat the beating in; after which about three more pieces of soft tenacious paper must be pasted and used in a similar way; back up with a piece of cartridge paper. The whole must then be dried with moderate heat, under a slight pressure. When thoroughly dry, brush well over with plumbago or French chalk. When this is done it is ready for the matrix. This is a box of a certain size for the work required, the interior of which is type high. In it is what is termed a gauge, which lifts out to insert your paper cast, and is regulated by hand to the size of the plate required. This being placed inside, the lid is shut down and screwed tight, with the end or mouthpiece left open. By this orifice the metal is poured in, and, as it is mounted to swing, the box is moved about so as to well throw down the metal and make a solid cast. Then water is dashed on the box, the screw-bar unshackled, the lid lifted, the plate taken off, and the paper cast is again ready for work.

Fusible Metal.—1. Bismuth, 8 parts; lead, 5 parts; tin, 3 parts: melt together. Melts below 212° Fahr. 2. Bismuth, 2 parts; lead, 5 parts; tin, 3 parts. Melts in boiling water 3. Lead, 3 parts; tin, 2 parts; bismuth, 5 parts: mix. Melts at 197° Fahr. Used for stereotyping; used to make toy-spoons, to surprise children by their melting in hot liquors; and to form pencils for writing on asses' skin, or paper prepared by rubbing burnt hartshorn into it.

Fusible Alloy, *for Silvering Glass.*—Tin, 6 oz.; lead, 10 oz.; bismuth, 21 oz.; mercury, a small quantity.

Muntz Metal.—6 parts copper; 4 zinc. Can be rolled and worked at a red heat.

Alloy for Cymbals and Gongs.—100 parts of copper with about 25 of tin. To give this compound the sonorous property in the highest degree, the piece should be ignited after it is cast, and then plunged immediately into cold water.

Alloy for Tam-Tams, or Gongs.—80 parts of copper and 20 of tin, hammered out with frequent annealing. An alloy of 78 of copper and 22 of tin answers better, and can be rolled out.

Alloy for Bells of Clocks.—The bells of the *pendules*, or ornamental clocks, made in Paris, are composed of copper 72·00, tin 26·56, iron 1·44 in 100 parts.

Bell Metal, *fine.*—71 copper, 26 tin, 2 zinc, 1 iron.

BELL METAL, *for large Bells.*—Copper, 100 lbs.; tin, from 20 to 25 lbs.

BELL METAL, *for small Bells.*—Copper, 3 lbs.; tin, 1 lb.

Cock Metal.—Copper, 20 lbs.; lead, 8 lbs.; litharge, 1 oz.; antimony, 3 oz.

Alloy for Journal Boxes.—Copper, 24 lbs.; tin, 24 lbs.; and antimony, 8 lbs. Melt the copper first, then add the tin, and lastly the antimony. It should be first run into ingots, then melted and cast in the form required for the boxes.

Queen's Metal.—A very fine silver-looking metal is composed of 100 lbs. of tin, 8 of regulus of antimony, 1 of bismuth, and 4 of copper.

Chinese Silver.—65·2 parts copper, 19·5 zinc, 13 nickel, 2·5 silver, and 12 cobalt of iron.

Hard White Metal.—Sheet brass, 32 oz.; lead, 2 oz.; tin, 2 oz.; zinc, 1 oz.

Metal for Taking Impressions.—Lead, 3 lbs.; tin, 2 lbs.; bismuth, 5 lbs.

White Metal.—Tin, 82; lead, 18; antimony, 5; zinc, 1; and copper 4 parts.

Metal for Tinning.—Malleable iron 1 lb., heat to whiteness; add 5 oz. regulus of antimony, and Molucca tin, 24 lbs.

Frick's German Silver.—53·39 parts copper, 17·4 nickel, 13 zinc.

Best Pewter.—5 lbs. tin to 1 lb. of lead.

Common Pewter.—82 parts pure tin, 18 parts lead.

Speculum Metal.—Equal parts of tin and copper form a white metal as hard as steel. Less tin and a small quantity of arsenic added to the alloy forms a white hard metal of high lustre. 2 lbs. copper, 1 lb. tin, 1 oz. arsenic, form a good speculum metal. An alloy of 32 copper, 16·5 tin, 4 brass, 1·25 arsenic is hard, white, and of brilliant lustre.

Type Metal.—9 parts lead to 1 antimony forms common type metal; 7 lead to 1 antimony is used for large and soft type; 6 lead and 1 antimony for large type; 5 lead and 1 antimony for middle type; 4 lead and 1 antimony for small type; and 3 lead to 1 antimony for the smallest kinds of type.

Statuary Metal.—91·4 parts copper, 5·53 zinc, 1·7 tin, 1·37 lead; or copper 80, tin 20.

Metal for Medals.—50 parts copper, 4 zinc.

Or-Molu.—The or-molu of the brass-founder, popularly known as an imitation of red gold, is extensively used by the French workmen in metals. It is generally found in combination with grate and stove work. It is composed of a greater portion of copper and less zinc than ordinary brass, is cleaned readily by means of acid, and is burnished with facility. To give this material the rich appearance, it is not unfrequently brightened up after "dipping" by means of a scratch brush, the action of which helps to produce a very brilliant gold-like surface. It is protected from tarnish by the application of lacquer.

Spanish Tutania.—Iron or steel, 8 oz.; antimony, 16 oz.; nitre, 3 oz. Melt and harden 8 oz. tin with 1 oz. of this compound.

Another Tutania.—Antimony, 4 oz.; arsenic, 1 oz.; tin, 2 lbs.

Gun Metal.—Bristol brass, 112 lbs.; zinc, 14 lbs.; tin, 7 lbs.

Rivet Metal.—Copper, 32 oz.; tin, 2 oz.; zinc, 1 oz.

RIVET METAL, *for Hose.*—Copper, 64 lbs.; tin, 1 lb.

Bullet Metal.—98 lead to 2 arsenic. For round shot the fused metal is dropped from a high elevation in a shot tower into a basin of water; or thrown down a stack of limited height, in which a strong draught of air is produced by a blast machine.

Pipe Metal for Organs.—Melt equal parts of tin and lead. This alloy is cast instead of rolled in the desired form of sheets, in order to obtain a crystallized metal, which produce a finer tone. The sheets are formed by casting the metal on a horizontal table, the thickness being regulated by the height of a rib or bridge at one end, over which the superfluous metal flows off. The sheets thus obtained are planed with a carpenter's plane, bent up, and soldered.

Aluminium Bronze.—100 parts copper and 10 aluminium, measured by weighing, when combined is a durable alloy, which may be forged and worked in the same manner as copper, and is the same colour as pale gold. 80 parts copper, 19 zinc, and 1 aluminium, form a good durable alloy.

Aquafortis.—*Simple or Single.*—Distil 2 lbs. of saltpetre and 1 lb. of copperas.

Double.—Saltpetre, 6 lbs., copperas, 6 lbs. in its usual crystallized state, together with 3 lbs. calcined to redness.

Strong.—Copperas calcined to whiteness, and white saltpetre, of each 30 lbs.

mix, and distil in an iron pot with an earthenware head.

Spirit of Nitre.—White saltpetre, 6 lbs.; oil of vitriol, $1\frac{1}{2}$ lb.: distil into $1\frac{1}{2}$ pint of water.

Dilute.—Strong aquafortis, 1 oz. by measure, and water 9 oz. by measure.

Proof.—The same as Assayer's Acid.

Compound.—Double aquafortis, 16 oz.; common salt, 1 dram: distil to dryness.

Aqua Regia.—Distil together 16 oz. of spirit of nitre, with 4 oz. of common salt; equal parts of nitric acid and muriatic acid mixed, or nitric acid 2 parts, and muriatic 1 part.

Amber, To Work.—Amber in the rough is first split and cut rudely into the shape required by a leaden wheel worked with emery powder, or by a bow saw having a wire for the blade, Tripoli or emery powder being used with it. The roughly-formed pieces are then smoothed with a piece of whetstone and water. The polishing is effected by friction with whiting and water, and finally with a little olive oil laid on and well rubbed with a piece of flannel, until the polish is complete. In this process the amber becomes hot and highly electrical; as soon as this happens it must be laid aside to recover itself before the polishing is continued, otherwise the article will be apt to fly into pieces.

Amber, To Mend.—Smear the parts which are to be united with linseed oil, hold the oiled part carefully over a small charcoal fire, a hot cinder, or a gas-light, being careful to cover up all the rest of the object loosely with paper; when the oiled parts have begun to feel the heat, so as to be sticky, pinch or press them together, and hold them so till nearly cold. Only that part where the edges are to be united must be warmed, and even that with care, lest the form or polish of the other parts should be disturbed; the part joined generally requires a little re-polishing.

Bleaching Silk.—A ley of white soap is made by boiling in water 30 lbs. of soap for every 100 lbs. of silk intended to be bleached, and in this the silk is steeped till the gum in the silk is dissolved and separated. The silk is then put into bags of coarse cloth and boiled in a similar ley for an hour. By these processes it loses 25 per cent. of its original weight. The silk is then thoroughly washed and steeped in a hot ley composed of $1\frac{1}{2}$ lb. of soap, 90 gallons of water, with a small quantity of litmus and indigo diffused. After this, it is carried to the sulphuring room: 2 lbs. of sulphur are sufficient for 100 lbs. of silk. When these processes are not sufficiently successful, it is washed with clear *hard* water and sulphured again.

Bleaching Wool.—The wool is first prepared according to the purposes for which it is intended, by treating it with solutions of soap. By this process it is cleared of a great quantity of loose impurity and grease which is always found in wool, often losing no less than 70 per cent. of its weight. The heat of the ley must be carefully attended to, as a high temperature is found to fix the unctuous matter or yolk of the wool. After washing, it is taken to a sulphur chamber, where it is exposed to the fumes arising from the slow combustion of sulphur, for from five to twenty hours, according to circumstances. It is again washed, and then immersed in a bath composed of pure whiting and blue. It is then exposed a second time to the fumes of the sulphur, and washed with a solution of soap, which renders it of the proper whiteness.

Paper Bleaching.—For bleaching rags, and other materials from which paper is at first fabricated, rags, when grey or coloured, are to be separated and ground in the paper-mill in the usual way, till brought to a sort of uniform consistence, having been previously macerated according to their quantity and tenacity. The mass is then treated with an alkaline ley. It is next treated with a solution of chloride of lime. If this immersion do not produce the desired effect, which does not often happen if the colours are tenacious, such as red and blue, let the treatment with the alkaline ley be repeated, and follow it

with another bath of the chlorine preparation. Then sour the whole in a bath of sulphuric acid, much diluted and cold, for when hot its action will be less effectual. Water is then to be run upon it till it comes off without colour or indication of acidity. Black is the most easily discharged colour, and will seldom require being treated with ley or steep of sulphuric acid, one bath of alkali and another of chloride of lime being sufficient to produce a good white. *Old printed* or *written paper* is first to be sorted according to its quality, and all the yellow edges cut off with a bookbinder's plane. One hundredweight of this paper is to be put sheet by sheet into vats sufficiently capacious, with 500 quarts of hot water. The whole is to be stirred for about an hour, and as much water gradually added as will rise about three inches above the paper, and to be left to macerate for four or five hours. It is then ground coarsely in the mill, and boiled in water for about an hour, taking care to add before it begins to boil, thirteen quarts of caustic alkaline ley. After boiling, it is macerated in the ley for twelve hours, when it is pressed, and, if sufficiently white, made into paper.

To Bleach Prints and Printed Books. — Simple immersion in oxygenated muriatic acid, letting the article remain in it, a longer or shorter space of time, according to the strength of the liquor, will be sufficient to whiten an engraving; if it be required to whiten the paper of a bound book, as it is necessary that all the leaves should be moistened by the acid, care must be taken to open the book well, and to make the boards rest on the edge of the vessel, in such a manner that the paper alone shall be dipped in the liquid; the leaves must be separated from each other, in order that they may be equally moistened on both sides. The liquor assumes a yellow tint, and the paper becomes white in the same proportion; at the end of two or three hours the book may be taken from the acid liquor, and plunged into pure water with the same care and precaution as recommended in regard to the acid liquor, that the water may touch both sides of each leaf. The water must be renewed every hour, to extract the acid remaining in the paper, and to dissipate the disagreeable smell. Printed paper may also be bleached by sulphuric acid, or by alkaline or soap leys.

Bleaching Ivory. — Antique works in ivory that have become discoloured may be brought to a pure whiteness by exposing them to the sun under glasses. It is the particular property of ivory to resist the action of the sun's rays, when it is under glass; but when deprived of this protection, to become covered with a multitude of minute cracks. Many antique pieces of sculpture in ivory may be seen, which, although tolerably white, are, at the same time, defaced by numerous cracks; this defect cannot be remedied; but, in order to conceal it, the dust may be removed by brushing the work with warm water and soap, and afterwards placing it under glass. Antique works in ivory that have become discoloured, may be brushed with pumice-stone, calcined and diluted, and while yet wet placed under glasses. They should be daily exposed to the action of the sun, and be turned from time to time, that they may become equally bleached; if the brown colour be deeper on one side than the other, that side will, of course, be for the longest time exposed to the sun.

Bleaching Powder. or Chloride of Lime, is prepared by passing chlorine gas into boxes of lead in which a quantity of slaked lime is laid on shelves. The stuff to be bleached is first boiled in lime water, wash, and without drying boil again, in a solution of soda or potash; wash, and without drying steep in a weak mixture of chloride of lime and water for six hours; wash, and without drying steep for four hours in a weak solution or mixture of sulphuric acid and water; wash well and dry; upon an emergency chlorate of potash mixed with three times its weight of common salt, and diluted in water, may be used as a *bleaching liquid.*

To Bleach Sponge.—Soak it well in dilute muriatic acid for twelve hours. Wash well with water, to remove the lime, then immerse it in a solution of hyposulphate of soda, to which dilute muriatic acid has been added a moment before. After it is bleached sufficiently, remove it, wash again, and dry it. It may thus be bleached almost snow white.

To Whiten Lace.—Lace may be restored to its original whiteness by first ironing it slightly, then folding it and sewing it into a clean linen bag, which is placed for twenty-four hours in pure olive oil. Afterwards the bag is to be boiled in a solution of soap and water for fifteen minutes, then well rinsed in lukewarm water, and finally dipped into water containing a slight proportion of starch. The lace is then to be taken from the bag and stretched on pins to dry.

Alcohol Barrels — Barrels or casks designed to be filled with alcohol, may be made tight by the application of the following solution:—Dissolve in a water bath 1 lb. of leather scraps and 1 oz. of oxalic acid, in 2 lbs. of water, and dilute gradually with 3 lbs. of warm water. Apply this solution to the inside of the barrel, where, by oxidation, it will assume a brown colour, and become insoluble in alcohol. This coat closes all the pores of the wood, and does not crack or scale off.

Paste Blacking.—Mix 1 part of ivory black, $\frac{1}{2}$ treacle, $\frac{1}{8}$ sweet oil, then add $\frac{1}{4}$ oil of vitriol and $\frac{1}{8}$ hydrochloric acid. Dilute each ingredient with three times its weight of water before mixing.

Liquid Blacking.—2 lbs. of ivory black in fine powder, treacle $1\frac{1}{2}$ lb., $\frac{1}{4}$ pint of sperm oil. Rub the black and oil well together, add the treacle and mix.

Another Method. — 4 oz. of ivory black, 3 oz. coarse sugar, a table-spoonful of sweet oil, and 1 pint of weak beer; mix them gradually together until cold.

Black Reviver.—Take 2 pints of vinegar, and infuse 1 oz. of iron filings, 1 oz. copperas, 1 oz. ground logwood, and 3 oz. bruised galls.

Blue Black is a paste made of ivory black and indigo, ground together with water.

Blue, *Soluble.*—7 parts oil of vitriol, place in a glass vessel, and set this in cold water, add gradually 1 part indigo in powder, stirring the mixture at each addition with a glass rod. Cover the vessel for twenty-four hours, then dilute with an equal quantity of water.

Boiler Incrustation.—The following remedies have been used with varying success to prevent incrustation:—

1. Potatoes, $\frac{1}{50}$th of weight of water prevents adherence of scale.
2. 12 parts salt, $2\frac{1}{2}$ caustic soda, $\frac{1}{8}$ extract of oak bark, $\frac{1}{2}$ potash.
3. Pieces of oak-wood suspended in boiler and renewed monthly.
4. 2 oz. muriate of ammonia in boiler twice a week.
5. A coating 3 parts of black-lead, 18 tallow, applied hot to the inside of the boiler every few weeks.
6. $12\frac{1}{2}$ lbs. of molasses fed into an 8-horse boiler at intervals, prevented incrustation for six months.
7. Mahogany or oak sawdust in small quantities. Use this with caution, as the tannic acid attracts iron.
8. Carbonate of soda.
9. Slippery elm bark.
10. Chloride of tin.
11. Spent tanners' bark.
12. Frequent blowing off.

Brightening and Colouring Brass.—The work to be brightened and coloured is first annealed in a red-hot muffle, or over an open fire, allowing the cooling to extend over one hour; the object of the heating being to remove the grease or dirt that may have accumulated during the process of fitting. Soft soldered work, however, must be annealed before fitted together, and afterwards boiled in a lye of potash; this is also done with work having ornamental surfaces. Next, it is immersed in a bath of diluted oil of vitriol or aquafortis, which may be made with two or three parts of water, and one of acid; but the old acid that contains a small quantity of copper, in solution, is

frequently preferred. The work is allowed to remain in this liquid for one or two hours, according to the strength of the acid; it is then well rinsed in water, and scoured with sand, which is applied with an ordinary scrubbing brush, and washed. The pickling bath is made by dissolving one part of zinc in three parts of nitric acid of 36° Baume, in a porcelain vessel, and adding a mixture of eight parts of nitric acid, and eight parts of oil of vitriol. Heat is then applied, and when the liquid is boiling the work is plunged into it for half a minute, or until the violent development of nitrous vapour ceases, and the surface is getting uniform. Then it is plunged into clean water, and well rinsed, to remove the acid. The ordinary, dark greyish, yellow tint, which is thus very often produced, is removed on immersing the work again in aquafortis for a very short time. Then it is plunged into clean or slightly alkaline water, well rinsed to remove the acid, and plunged into warm dry beech or boxwood saw-dust, and rubbed until quite dry. To prevent the action of the atmosphere it is lacquered; if a green tint is to be produced, the lacquer is coloured with turmeric. A dark, greyish, but agreeable tint, is obtained by immersing the work previously in a solution of white arsenic in hydrochloric acid, or in a solution of bichloride of platinum, under addition of some vinegar, or rubbing with plumbago.

Bronze for Statuary.—1. Copper, 88 parts; tin, 9 parts; zinc, 2 parts; lead, 1 part. 2. Copper, 88½ parts; tin, 5 parts; zinc, 10½ parts; lead, 2 parts. 3. Copper, 90 parts; tin, 9 parts; lead, 1 part. 4. Copper, 91 parts; tin, 9 parts.

For Medals.—1. Copper, 89 parts; tin, 8 parts; zinc, 3 parts. 2. Copper, 95 parts; tin, 5 parts.

For Cutting Instruments.—Copper, 100 parts; tin, 14 parts.

For Ornaments.—1. Copper, 82 parts; tin, 3 parts; zinc, 18 parts; and lead, 2 parts. 2. Copper, 83 parts; zinc, 17 parts; tin, 1 part; lead, ½ part.

Bronze Liquid.—Take 1 pint of strong vinegar, 1 oz. of sal ammoniac, ½ oz. of alum, ¼ oz. of arsenic; dissolve them in the vinegar, and the compound is fit for use. We know brass-founders who have been in the habit of using this for several years, and, where the metal is good, it is seldom found to fail.

Bronze Powders, *Aurum Musivum.*—Melt together, in a crucible over a clear fire, equal parts of sulphur and the white oxide of tin. Keep them continually stirred with the stem of an earthenware pipe or glass rod, till they assume the appearance of a yellow flaky powder.

An iron rod must not be used in stirring up any mixture of sulphur when melted, or the sulphur and iron will unite. *Aurum Musivum*, or *Mosaic Gold*, is used as a cheap bronze powder. It is rubbed on with the finger. Another way to prepare it is to take quicksilver, tin, sulphur, and sal ammoniac, equal parts. First melt the tin, then pour the quicksilver into it, afterwards grind up with the amalgam thus made the sulphur and sal ammoniac. Place the mixture in a crucible, and heat until the powder in the crucible becomes gold-coloured, and also until no fumes of quicksilver arise.

Copper-coloured Bronze may be obtained by dissolving copper in aquafortis until it is saturated, and then putting into the solution some small pieces of iron, when the copper will be precipitated in the metallic state; the fluid must then be poured off, and the powder carefully washed, dried, and levigated, when it may be put by for use.

Bronze powder is sometimes made from Dutch gold, which is sold in books at a very low price. All these inferior bronzes require to be covered with a coat of clear varnish, or they will very soon lose their metallic appearance, nor will the varnish entirely prevent, although it will greatly retard, this change.

Cheap Bronze.—Verdigris, 8 oz.; flowers of zinc or tutti powder, 4 oz.; borax and nitre, of each 2 oz.; corrosive sublimate, 2 drachms, made into a paste

with oil, and melted together. Used in the commoner kinds of tea-boards, &c.

Silver Bronze.—Bismuth and tin, of each 2 lbs.; melt together and add 1 lb. of quicksilver. Pound all together into a powder.

This soft fusible amalgam is used as an imitation of silver bronze for plaster figures and other common purposes, in the same way as the aurum musivum is for gold-coloured articles. It may be used as spangles in sealing-wax; it must then be mixed when the resinous part of the wax is getting cold.

Gold Powder for Bronzing.—Leaf gold is ground with virgin honey on a stone, until the leaves are broken up and minutely divided. The mixture is removed from the stone by a spatula, and stirred up in a basin of water, whereby the honey is melted and the gold set free; the basin is then left undisturbed until the gold subsides; the water is poured off, and fresh quantities added until the honey is entirely washed away; after which the gold is collected on filtering paper, and dried for use.

Gold Size is prepared from ½ lb. of linseed oil with 2 oz. of gum animi; the latter is reduced to powder and gradually added to the oil while being heated in a flask, stirring it after every addition until the whole is dissolved; the mixture is boiled until a small quantity, when taken out, is somewhat thicker than tar, and the whole is strained through a coarse cloth. When used, it must be ground with as much vermilion as will render it opaque, and at the same time be diluted with oil of turpentine, so as to make it work freely with the pencil.

Bronzing Plaster. — Lay the figure over with isinglass size, until it holds out, or without any part of its surface becoming dry; then, with a brush, such as is termed by painters a sash tool, go over the whole, taking care to remove, while it is yet soft, any of the size that may lodge on the delicate parts of the figure. When it is dry take a little very thin oil *gold size*, and with as much as just damps the brush, go over the figure with it, allowing no more to remain than causes it to shine. Set it aside in a dry place free from smoke, and in forty-eight hours the figure is prepared to receive the bronze.

After having touched over the whole figure with the bronze powder, let it stand another day, and then with a soft dry brush rub off all the loose powder, particularly from the points, or more prominent parts of the figure.

Bronzing Wood.—The wood is first covered with a uniform coating of glue, or of drying oil, and when nearly dry the bronze powder, contained in a small bag, is dusted over it. The surface of the objects is afterwards rubbed with a piece of moist rag. Or the bronze powder may be previously mixed with the drying oil, and applied with a brush.

Bronzing Paper.—Gum is substituted for drying oil in bronzing paper When dry, the paper is submitted to the action of the burnisher, which imparts great brilliancy to it.

Bronzing small Brass Articles.—1 part oxide of iron, 1 part white arsenic, 12 parts hydrochloric acid. Clean the brass well to get rid of lacquer or grease, and apply with a brush until the desired colour is obtained. Stop the process by oiling well, when it may be varnished or clear lacquered.

Bronzing Gas Fittings.—Boil the work in strong ley, and scour it free from all grease or old lacquer; pickle it in diluted nitric acid till it is quite clean (not bright), then dip in strong acid, and rinse through four or five waters; repeat the dip, if necessary, till it is bright; next bind it very loose with some thin iron wire, and lay it in the strongest of the waters you have used for rinsing. This will deposit a coat of copper all over it if the water or pickle be not too strong; if such is the case the copper will only be deposited just round where the wire touches. When the copper is of sufficient thickness wash it again through the waters, and dry it with a brush in some hot saw-dust; box-dust is best, but if this is

not at hand, oak, ash, or beech will do. It is now ready for bronzing. The bronze is a mixture of black-lead and red bronze, varied according to shade required, mixed with boiling water. The work is to be painted over with this and dried, then brushed until it polishes. If there are any black spots or rings on the work, another coat of the bronze will remove them. Lacquer the work with pale lacquer, or but very slightly coloured, for if it is too deep it will soon chip off.

Another method is to mix vinegar or dilute sulphuric acid (1 acid 12 water) with powdered black-lead in a saucer or open vessel; apply this to the brass with a soft plate brush by gentle brushing. This will soon assume a polish, and is fit for lacquering. The brass must be made slightly warmer than for lacquering only. A little practice will enable the operator to bronze and lacquer with once heating. The colour, black or green, varies with the thickness of black-lead.

Green Bronze.—Dissolve 2 oz. of nitrate of iron, and 2 oz. of hyposulphite of soda in 1 pint of water. Immerse the articles in the bronze till of the required tint, as almost any shade from brown to red can be obtained; then well wash with water, dry, and brush. One part of perchloride of iron and two parts of water mixed together, and the brass immersed in the liquid, gives a pale or deep olive green, according to the time of immersion. If nitric acid is saturated with copper, and the brass dipped in the liquid, and then heated, it assumes a dark green. If well brushed, it may be lacquered with pale gold lacquer, or else polished with oil.

Black Brasswork for Instruments.—Take lampblack, about a thimbleful, and put it on a flat stone or smooth slate; add four or five spots of gold size, and well mix with a palette knife, make the whole about as thick as putty; well mix. The less gold size there is the better, so that the lampblack just sticks together; if too much gold size be added, the effect will be a bright black and not a dead black. Now add turpentine, about twice its own volume, to the whole, mix with a camel-hair brush, and apply to the brasswork.

Black Bronze for Brass.—Dip the article bright in aquafortis; rinse the acid off with clean water, and place it in the following mixture until it turns black:—Hydrochloric acid, 12 lbs.; sulphate of iron, 1 lb.; and pure white arsenic, 1 lb. It is then taken out, rinsed in clean water, dried in saw-dust, polished with black-lead, and then lacquered with green lacquer.

Bronzing Iron.—To one pint of methylated finish add 4 oz. of gum shellac and ½ oz. gum benzoin; put the bottle in a warm place, shaking it occasionally. When the gum is dissolved let it stand in a cool place two or three days to settle, then gently pour off the clear into another bottle, cork it well, and keep it for finest work. The sediment left in the first bottle, by adding a sufficient quantity of spirit to make it workable, will do for the first coat or coarser work when strained through a fine cloth. Next get ½ lb. of finely-ground bronze green, the shade may be varied by using a little lampblack, red ochre, or yellow ochre; let the iron be clean and smooth, then take as much varnish as may be required, and add to the green colour in sufficient quantity; slightly warm the article to be bronzed, and with a soft brush lay a thin coat on it. When that is dry, if necessary lay another coat on, and repeat until well covered. Take a small quantity of the varnish and touch the prominent parts with it; before it is dry, with a dry pencil lay on a small quantity of gold powder. Varnish over all.

Bronzing Copper Utensils.—If the article is not new take it to pieces, wiping off all the solder with a wisp of tow, and taking care not to let any of the metal in the fire; then twist a little tow on the end of a stick, and pickle with spirits of salts all those parts that are tinned, pickling the outside as well as the in, rinse in water, and scour outside with wisp of tow and sand, fine coke-dust is best for the

tinned parts, which must be brought quite clean, rinse clean, smear the outside with wet whiting, and then tin with bar tin, sal ammoniac being the best agent; then pickle only the outside with diluted spirits of salts, rinse, and scour with clean sand till the surface is perfectly clean and bright, taking care to rub as much as possible in one direction. The cast parts and those not tinned are pickled in dilute oil of vitriol, and scoured with sand, same as the body; beat with a brush, then dried in saw-dust, and the article is now ready for bronzing. Procure some crocus, some knowledge is wanted to select a good one, as it may be too light, or too dark, or too fine, or too coarse; then make into a thick cream with water. Having used a forge fire to tin with, to be on the safe side it is best to rake out all the old coke and light afresh, and the coke should be a nice, clear, firm, grey ore, in pieces the size of a walnut; also have some clear bright coal, then blow up a clear bright fire, and heap up plenty of coke that the sulphur may burn off; now take a little of the mixed crocus and brush up the body, using a hard brush; get all the crocus off clean, and wipe with a clean piece of rag, and it is best to hold with this, as the perspiration of the hand will prevent the colour taking; now blow up fire, making a hole in centre, so that a good blast comes up, and having painted the body evenly with the red cream so that the colour does not run (a flat camel-hair brush, 2½ inches wide, is the best thing to do it with), hold it with the tongs and turn it steadily so that all parts are exposed fairly to the blast. As soon as it is dry, throw into the fire a bit of coal about the size of a Spanish nut, more or less to size of work, and let the work have an even coat of smoke till it is quite black, but no more (if the coal is not burnt out hold the work on one side), then turning it steadily, keep up a sharp blast till the smoke is burnt off, and stand it to cool. Treat cast parts the same, but as soon as the smoke is burnt off, dip them into clean cold water, else, on account of their thickness the colour will burn; when cold, wipe the crocus off the body with wisp of clean tow, then brush hard till quite clean, wipe with rag and repeat the above once or twice, according to the shade required. To finish properly the body is hammered all over with bright hammers shaped to parts, and on suitable tools which are covered with two or three folds of lasting; the inside is scoured bright, and the parts soldered together, using resin. Medals only want brushing up with wet crocus, taking care not to touch with hand, and then colouring as above. Only copper coins can be so bronzed.

Copper Articles may also be bronzed by the following process:—Dissolve in vinegar two parts verdigris and one part sal ammoniac. Boil, skim, and dilute with water, until white precipitate ceases to fall. Set in a pan meanwhile the articles to be bronzed, made perfectly clean and free from grease. Boil solution briskly and pour over the articles in the pan and boil them briskly. A bright reddish-brown colour is thus acquired; but the articles should be frequently inspected, and removed as quickly as the desired shade is obtained. Then they are to be repeatedly washed and dried. The solution must not be too strong, for then the bronze will come off by friction, or turn green on exposure to the air.

To Bronze Electrotypes, *Green.* — Steep the medal or figure in a strong solution of common salt or sugar, or sal ammoniac, for a few days, wash in water and allow to dry slowly, or suspend over a vessel containing a small quantity of bleaching powder, and cover over—the length of time it is allowed to remain will determine the depth of the colour.

Brown.—Four or five drops of nitric acid to a wine-glassful of water, and allowed to dry, and when dry impart to the object a gradual and equal heat; the surface will be darkened in proportion to the heat applied.

Black. — Wash the surface of the object over with a little sulphurate of ammonia (dilute), and dry at a gentle

heat, polish with a hard brush afterwards.

Browning Gun Barrels.—Chloride of antimony has been much used for bronzing gun barrels, is excellent in its operation, and has been called, in consequence, bronzing salt. It is used for bronzing, mixed to a thin creamy consistence with olive oil; the iron is slightly heated, dressed evenly upon its surface with this mixture, and left until the requisite degree of browning is produced. The sharpening of the chloride of antimony can be effected by adding a little nitric acid to the paste of olive oil and chloride of antimony, so as to hasten the operation. Another formula is—Aquafortis, ½ oz.; sweet spirit of nitre, ½ oz.; spirit of wine, 1 oz.; blue vitriol, 2 oz.; tincture of chloride of iron, 1 oz.; water, 40 oz. Dissolve the blue vitriol in the water, then add the other materials, and the water is warmed to dissolve the blue vitriol; let it get cold before adding the other materials. The burnishing and marking can be effected with the burnisher and scratch brush. The polishing is best effected by rubbing with a piece of smooth, hard wood, called polishing wood. It is lastly varnished with shellac varnish, and again polished with the hard wood polisher. Some prefer the tone of brown produced by blue vitriol, 1 oz.; sweet spirit of nitre, 1 oz.; water, 20 oz. In any case, the surface of the iron must be well cleaned, and rendered quite bright; it is then freed from grease by rubbing with whiting and water, or better, with powdered quicklime and water. The browning composition is then placed on, and allowed to remain twenty-four hours. It is then rubbed off with a stiff brush. If not sufficiently browned, repeat the last process after browning. Clean the surface well with hot water containing a little soda or potash, and, lastly, with boiling water, and dry it. The surface can be burnished and polished. Varnish with tinsmith's lacquer, or with gum shellac, 2 oz.; dragon's blood, 3 drs.; methylated spirits of wine, 4 pints. The metal should be made hot before applying this varnish, and will present an excellent appearance. If the varnish is not required to colour, but only to preserve the actual tint produced on the metal surface by the browning fluid, leave out the dragon's blood.

Catgut, To Make. — Take the entrails of sheep, or any other animal, procured from the newly-killed carcass. Thoroughly clean them from all impurities and from attached fat, and wash them well in clean water; soak in soft water for two days, or in winter three days, then lay them on a table and scrape them with a small plate of copper, having a semicircular hole cut in it, the edges of which must be quite smooth and not capable of cutting. Now, after washing, put them into fresh water, and there let them remain till the next day, when they are again to be scraped. Let them soak again in water for a night, and two or three hours before they are taken out add to each gallon of water 2 oz. of pearlash. They ought now to scrape quite clean from their inner mucous coat, and will consequently be much smaller in dimensions than at first. They may now be wiped dry, slightly twisted, and passed through a hole in a piece of brass, to equalize their size; as they dry, they are passed every two or three hours through other holes, each smaller than the last. When dry they will be round and well polished, and being oiled are fit for use.

Cameos, To Carve.—Take the common helmet, or the red helmet shell (those shells whose inner surface is pink or dark coloured are most suitable), cut them into squares with a lapidary's mill, round off the corners, and shape them into an oval on a wet grindstone. Fix the enamel side on a short stick with jeweller's cement, grind off the brittle surface, sketch the subject with a black-lead pencil, cut the subject with engraver's tools, namely, a chisel tool to clear the bare places; a lozenge-shape for forming the subject, and a scraper, made of a three-angled file, ground off taper to the point, for cleaning the enamel surface round the subject, and also for forming the lineaments and other delicate parts The colour on the cheeks and hair is

produced by leaving the layer of coloured shell on those places. The stick must be grasped in the left hand, and held firmly against a steady bench, and with the tool resting in the hollow of the right hand, dig away the shell. A convenient length for the tools is three inches and a half; they must be kept in good condition to work with accuracy. The cameos are polished with a cedar stick, or a piece of cork dipped in oil of vitriol and putty powder, and cleaned with soap and water. Mother-of-pearl is carved in the same way.

Cements, How to Use.—Take as small a quantity of the cement as possible, and bring the cement itself into intimate contact with the surfaces to be united. If glue is employed, the surface should be made so warm that the melted glue is not chilled before it has time to effect a thorough adhesion. Cements that are used in a fused state, as resin or shellac, will not adhere unless the parts to be joined are heated to the fusing point of the cement. Sealing-wax, or ordinary electrical cement, is a good agent for uniting metal to glass or stone, provided the masses to be united are made so hot as to fuse the cement, but if the cement is applied to them while they are cold it will not stick at all. This fact is well known to the itinerant vendors of cement for uniting earthenware. By heating two pieces of china or earthenware so that they will fuse shellac, they are able to smear them with a little of this gum, and join the pieces so that they will rather break at any other part than along the line of union. But although people constantly see the operation performed, and buy liberally of the cement, it will be found in nine cases out of ten that the cement proves worthless in the hands of the purchasers, simply because they do not know how to use it. They are afraid to heat a delicate glass or porcelain vessel to a sufficient degree, or they are apt to use too much of the material, and the result is a failure.

Cement for Aquariums.—1. Take 1 gill of plaster of Paris, 1 gill of litharge, 1 gill of fine white sand, $\frac{1}{3}$ of a gill of finely-powdered resin. Mix well, and bottle and cork it until wanted for use, then mix it with boiled oil and dryers until as thick as putty. Mix the cement only in small quantities, as it dries quickly. 2. Mix boiled linseed oil, litharge, red and white lead together, using white-lead in the largest proportion, spread on flannel, and place on the joints. 3. A solution of glue, 8 oz. to 1 oz. of Venice turpentine; boil together, agitating all the time, until the mixture becomes as complete as possible, the joints to be cemented to be kept together for forty-eight hours if required. 4. Take $\frac{1}{2}$ a gill of gold size, 2 gills of red-lead, $1\frac{1}{2}$ gill of litharge, and sufficient silver-sand to make it into a thick paste for use. This mixture sets in about two days.

Armenian, or Jeweller's Cement.—Dissolve 5 or 6 bits of gum mastic the size of a large pea, in as much spirits of wine as will suffice to render it liquid; in a separate vessel dissolve as much isinglass (previously softened in water, though none of the water must be used) in rum, or other spirit, as will make a 2-oz. phial of very strong glue, adding two small pieces of gum ammoniacum, which must be rubbed or ground till they are dissolved; then mix the whole with a sufficient heat. Keep it in a phial closely stopped, and when it is to be used, set the phial in boiling water. The preceding is also effectual in uniting almost all substances, even glass, to polished steel.

Acid Proof Cement.—Make a concentrated solution of silicate of soda, and form a paste with powdered glass. This simple mixture will sometimes be found invaluable in the operations of the laboratory where a luting is required to resist the action of acid fumes.

Cutler's Cement.—1. Resin, 4 parts, to 1 part beeswax and 1 part of brick-dust, or plaster of Paris. 2. Sixteen parts resin, 16 hot whiting, and 1 wax. 3. Pitch, 4 parts; resin, 4; tallow, 2; and brick-dust, 2. The opening for the blade is filled with one of these compositions. The lower end of the iron heated and pressed in.

Cement for Bottle-Corks.—The bituminous or black cement for

bottle-corks consists of pitch hardened by the addition of resin and brick-dust.

Cement for Ivory, or Mother-of-Pearl.—Dissolve 1 part of isinglass and 2 of white glue in 30 of water, strain and evaporate to 6 parts. Add $\frac{1}{30}$th part of gum mastic, dissolved in $\frac{1}{2}$ a part of alcohol, add 1 part of zinc white. When required for use, warm and shake up.

Cement for Jet.—Shellac is the only cement used by jewellers for jet articles. The broken edges should be made warm before applying the cement. Should the join be in sight, by smoking the shellac before applying it, it will be rendered the same colour as the jet itself.

Cement for Meerschaum.—Take some garlic and crush it, in order to form a kind of dough, rub over the broken pieces of Meerschaum with it and reunite them by drawing very closely, bind them with iron wire according to the strength of the pieces, and finally make them boil during half an hour in a sufficient quantity of milk. Or use quicklime mixed to a thick cream with the white of an egg. These cements will also unite glass or china.

Plumber's Cement.—Black resin, 1 part; brick-dust, 2 parts; well incorporated by a melting heat.

Turner's Cement.—1. Take of Burgundy pitch, 2 lbs.; of resin, 2 lbs.; of yellow wax, 2 oz.; and of dried whiting, 2 lbs.: melt and mix. 2. Black resin, $\frac{1}{2}$ lb.; yellow wax, 1 oz.; melt together, and pour into a tin canister. When wanted for use, chip out as much as will cover the chuck to the $\frac{1}{16}$th of an inch, spread it over the surface in small pieces, mixing it with an eighth of its bulk of gutta-percha in thin slices; then heat an iron to a dull red heat, and hold it over the chuck till the mixture and gutta are melted and liquid; coil the iron a little, and with it stir the cement until it is homogeneous; chuck the work, lay on a weight to enforce contact, leave it at rest for half an hour, when it will be ready for the lathe. 3. Four parts resin melted with 1 part pitch; while these are boiling add brick-dust until by dropping a little upon a cold stone you think it hard enough.

Indianite Cement.—1. 100 parts finely-chopped rubber, 15 resin, 10 shellac, dissolved in a sufficient quantity of bisulphide of carbon. Used for uniting pieces of india-rubber. 2. India-rubber, 15 grs.; chloroform, 2 oz.; mastic, $\frac{1}{2}$ oz. The two first-named to be mixed, and after the rubber is dissolved add the mastic in powder; allow to macerate for a week.

Cheap India-rubber Cement.—Cut virgin or native india-rubber with a wet knife into the thinnest possible slices, and with shears divide these into threads as fine as fine yarn. Put a small quantity of the shreds (say $\frac{1}{10}$th or less of the capacity of the bottle) into a wide-mouthed bottle, and fill it three-quarters full with benzine of good quality, perfectly free from oil. The rubber will swell up almost immediately, and in a few days, especially if often shaken, assume the consistence of honey. If it incline to remain in undissolved masses, more benzine must be added; but if too thin and watery it needs more rubber. A piece of solid rubber the size of a walnut will make a pint of the cement.

This cement dries in a few minutes, and by using three coats in the usual manner, will unite leather straps, patches, rubber soles, backs of books, &c., with exceeding firmness.

Cement, Elastic.—Bisulphide of carbon, 4 oz.; fine india-rubber in shreds, 1 oz.; isinglass, 2 drachms; gutta-percha, $\frac{1}{2}$ oz.; dissolve. Used for cementing leather or india-rubber. The parts to be joined must be coated thinly with the solution, and allowed a few minutes to dry, then heat to melting; place the parts together and well hammer the air bubbles out.

Cement for Mounting Photographic Prints.—Fine wheat starch, 4 drachms; beat into a paste with cold water 1 oz. of best Russian glue; dissolve in a pint of boiling water; while boiling pour on the starch; put the whole into a saucepan, and boil till as thick as treacle. When required for

use a small quantity is to be melted in a little warm water.

Cement for Wood Vessels required to be Water-tight.—A mixture of lime-clay and oxide of iron separately calcined and reduced to fine powder, then intimately mixed, kept in a close vessel, and mixed with the requisite quantity of water when used.

Cement for Leather.—A good cement for splicing leather for straps is gutta-percha dissolved in bisulphide of carbon, until it is of the thickness of treacle; the parts to be cemented must first be well thinned down, then pour a small quantity of the cement on both ends, spreading it well so as to fill the pores of the leather, warm the parts over a fire for about half a minute, apply them quickly together, and hammer well. The bottle containing the cement should be tightly corked and kept in a cool place.

Marble Cement.—Take plaster of Paris, and soak it in a saturated solution of alum, then bake in an oven, the same as gypsum is baked to make it plaster of Paris; after which grind the mixture to powder. It is then used as wanted, being mixed up with water like plaster and applied. It sets into a very hard composition capable of taking a very high polish, and may be mixed with various colouring minerals to produce a cement of any colour capable of imitating marble. This cement is also used for attaching glass to metal.

Impervious Cement for Apparatus, Corks, &c.—Zinc white, rubbed up with copal varnish to fill up the indentures; when dry, to be covered with the same mass, somewhat thinner; and lastly, with copal varnish alone.

Chinese Cement.—Finest pale orange shellac, broken small, 4 oz.; rectified spirit (the strongest 58 o.p.) 3 oz.; digest together in a corked bottle in a warm place until dissolved; it should have the consistence of treacle. For wood, glass, ivory, jewellery, and all fancy works, used.

Cements for Cracks in Wood.—Make a paste of slacked lime, 1 part; rye meal, 2 parts; with a sufficient quantity of linseed oil. Or, dissolve 1 part of glue in 16 parts of water, and when almost cool stir in saw-dust and prepared chalk a sufficient quantity. Or, oil-varnish thickened with a mixture of equal parts of white-lead, red-lead, litharge, and chalk.

Cements for Joining Metals, or Glass and Wood.—Melt resin and stir in calcined plaster until reduced to a paste, to which add boiled oil a sufficient quantity to bring it to the consistence of honey; apply warm. Or, melt resin 180 parts, and stir in burnt umber, 30; calcined plaster, 15; and boiled oil, 8 parts. Or, dissolve glue in boiling water to the consistence of cabinet-maker's glue, then stir in sufficient wood ashes to produce a varnish-like mixture. While hot, the surfaces to be united must be covered with this compound and pressed together.

Stonemason's Cement.—Clean river sand, 20 lbs.; litharge, 2 lbs.; quicklime, 1 lb.; linseed oil, sufficient to form a thin paste. This cement is applied to mend broken pieces of stone, and after a time it becomes exceedingly hard and strong. A similar composition has been used to coat brick walls, under the name of mastic.

Fireproof and Waterproof Cement.—To 4 or 5 parts of clay, thoroughly dried and pulverized, add 2 parts of fine iron filings free from oxide, 1 part of peroxide of manganese, ½ part of sea salt, and ½ part of borax. Mingle these thoroughly and render them as fine as possible, then reduce them to a thick paste with the necessary quantity of water, mixing thoroughly well. It must be used immediately After application it should be exposed to heat gradually increasing almost to a white heat. This cement is very hard, and presents complete resistance alike to a red heat and boiling water. Another method:—To equal parts of sifted peroxide of manganese and well-pulverized zinc white, add a sufficient quantity of commercial soluble glass to form a thin paste. This mixture, when used immediately, forms a cement quite equal in hardness and resistance to that obtained by the first method.

Electrical or Chemical Cement.—A good cement for chemical and electrical apparatus may be prepared by mixing 5 lbs. of resin, 1 lb. of wax, 1 lb. of red ochre, and 2 oz. of plaster of Paris, and melting the whole with moderate heat.

Engineers' Cements for Making Joints.—1. Mix ground white-lead with as much finely-powdered red-lead as will make it the consistence of soft putty. 2. Mix equal parts of white-lead and red-lead, and add as much boiled linseed oil as is required to give it the proper consistence; or boiled linseed oil and red-lead mixed into a putty. These cements are used for making metallic joints sound.

Iron Cements, or Rust Joints.—1. 1 lb. clean iron borings, pounded fine in a mortar, 2 oz. sal ammoniac in powder, 1 oz. flour of sulphur. The whole mixed by pounding, and to be kept dry. For use, mix 1 part of the above with 20 of iron borings pounded, adding water to the consistence of mortar. 2. 2 lbs. clean iron borings, 1 oz. flour of sulphur, 1 oz. sal ammoniac. 3. 98 parts of fine iron borings through a sieve, 1 flour of sulphur, 1 sal ammoniac. Mix and dissolve in boiling water when required for use. 4. Mix 1 lb. fine borings, $\frac{1}{2}$ oz. sal ammoniac, pounded small, $\frac{1}{2}$ oz. spirits of salts, and a little water. Prepare the joint by bringing the inner joint rings of the flanges together—screwing up the bolts firmly; in this condition there should be an annular space between the flanges of from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. in width; a strand of rope-yarn or any soft fibre should now be stuffed to the bottom of the joint, so as to prevent the jointing material from being driven through in the process of calking. A good hammer, a calking iron rather thinner than the joint, and a flat piece of wood or sheet iron should be in readiness. Take a suitable quantity of fine cast-iron borings, free from dust, and which may be passed through a sieve to remove large pieces; next dissolve a very small piece of sal ammoniac in water, say a drachm to a quart. In the absence of sal ammoniac to mix up the borings with, the urine of any animal does quite as well. Now mix the borings with sufficient of the fluid to cause them to adhere together in lumps when compressed in the hand. It is now ready for use. By means of the calking iron, and the piece of board or plate, stuff the moist material into the joint to a depth of 1 in. or so from the bottom, all round; now calk it down with the iron and hammer until it sounds perfectly solid, as though it struck against solid iron. Repeat the process of filling, then the calking, and so on, until the joint is filled to the surface. The joint should rest for at least ten hours before being put under pressure.

Cement to Mend Iron Pots and Pans.—Take 2 parts of sulphur, and 1 part, by weight, of fine black-lead; put the sulphur in an old iron pan, holding it over the fire until it begins to melt, then add the lead; stir well until all is mixed and melted; then pour out on an iron plate, or smooth stone. When cool, break into small pieces. A sufficient quantity of this compound being placed upon the crack of the iron pot to be mended, can be soldered by a hot iron in the same way a tinsmith solders his sheets. If there is a small hole in the pot, drive a copper rivet in it and then solder over it with this cement.

London Cement.—Boil a piece of Gloucester cheese three times in water, each time allowing the water to evaporate. Take the paste thus left and thoroughly incorporate with dry quicklime. It will mend glass, wood, china, &c., very effectually.

Architectural Cement.—Strong rice-water size and paper pulped in boiling water are mixed together; enough whiting is then added to make it of a proper consistence.

Renovating Files.—The file to be first cleansed from all foreign matter, and then dipped in a solution of 1 part nitric acid, 3 parts sulphuric acid, and 7 parts water; the time of immersion will be according to the extent the file has been worn and the fineness of the teeth, varying from 5 seconds to 5 minutes. On taking it out of the mixture, wash in

water, then dip in milk of lime, wash off the lime, dry by a gentle heat, rub over equal parts of olive oil and turpentine, and finally brush over with powdered coke.

Galvanic Method.—Well-worn files are first carefully cleaned by means of hot water and soda; then placed in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid, 80 parts of nitric acid, and 1000 parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises towards the surface. When the files have been ten minutes in the bath they are taken out, washed, and dried.

Softening Files.—Cover them with oil and hold them over the fire until the oil blazes, as soon as the flame runs all over the file, plunge it in the water; or put them in a moderate hot oven for half an hour if large files, but if small the first plan is the best.

Softening Cast Iron.—Heat the metal to a bright red, cool quickly in water, reheat, and then anneal by cooling slowly in ashes. Or, heat the metal to a red heat, let it lie a few minutes until nearly black, and then throw it into soapsuds.

Softening Castings.—Place the castings, surrounded by saw-dust, in an iron box, close it up with clay to exclude the air, and subject it to a red heat for several hours. The castings must be cold before they are withdrawn.

Hardening and Tempering Tools and Metals.—The following is the colour and temperature required:—Pale straw, 430° Fah., for lancets, &c.; dark yellow, 470° Fah., for razors, &c.; dark straw, 470° Fah., for penknives; clay yellow, 490° Fah., for chisels and shears; brown yellow, 500° Fah., for adzes and plane irons; very pale purple, 520° Fah., for table-knives; light purple, 530° Fah., for swords and watch-springs; dark purple, 550° Fah., for softer swords and watch-springs; dark blue, 570° Fah., for small fine saws; blue, 590° Fah., for large saws; pale blue, 610 Fah., for saws, the teeth of which are set with pliers; greenish blue, 630 Fah., for very soft temper. To obtain the proper temper lay the metal on a lump of iron heated to a sufficiently strong heat in the forge or other fire. The desired temper may be thus secured with the greatest facility and exactitude, as the clean bright metal shows the degrees of oxidation from the blue upwards most distinctly, which oxidation can be arrested at will. Cleanliness, or rather brightness of surface, is essential.

Tempering Mill Picks and Chisels.—Heat the bill to a blood-red heat, and then hammer it till nearly cold; again heat it to a blood red, and quench as quick as possible in three gallons of water, in which is dissolved 2 oz. of oil of vitriol, 2 oz. of soda, and ½ oz. of saltpetre; or, 2 oz. of sal ammoniac, 2 oz. spirit of nitre, 1 oz. oil of vitriol. The bill to remain in the liquor until it is cold. 2. 1 oz. white arsenic, 1 oz. spirits of salts, 1 oz. sal ammoniac, dissolved in four gallons of spring water, and kept in a tube or iron phial for use. Heat the tool to a blood-red heat, then quench it in this mixture, draw it gently over the clean fire till the spittle flashes off it, then let it cool. 3. To 3 gallons of water add 3 oz. of spirit of nitre, 3 oz. of spirits of hartshorn, 3 oz. of white vitriol, 3 oz. of sal ammoniac, 3 oz. of alum, 6 oz. of salt, with a double handful of hoof parings; the steel to be heated a dark cherry red. Used to temper chisels for cutting French burr stones.

Tempering Cast Steel.—Dissolve a small quantity of sal ammoniac in water, make the metal red, drop it into the mixture for a second or two, and take it out, leaving enough heat in the metal to draw it back a bit. If left till cold, the steel will be a great deal too hard.

Tempering Springs.—Get a piece of spring steel about the size of spring wanted; when forged and filed to tilt, make it warm-red, immerse in spring water (a little cow-dung improves it, mixed well with the water

before using it). Dry the spring, then tie a piece of wire fast to the spring in any form, so as to hold it. Dip in clean tallow or oil, put it on the fire till all the grease is burnt off, and swing round and round as swift as you can till cold.

Malleable Iron.—2 oz. fluoric acid, 1 oz. nitric acid, 1 oz. saltpetre, to 10 lbs. of metal. When the metal is melted, add the solution. It can be made in a crucible in a brass furnace. When you have cast off patterns, the castings want keeping at red heat for three or four days in iron boxes in a furnace.

Casehardening Iron.—Procure a quantity of old boots, burn these until they become charred, beat off the black and charred portion with a hammer, until sufficient powdered carbon is obtained; then place this powder with the articles to be operated upon into a sheet-iron box or a piece of wrought-iron gas-pipe sufficiently large, taking care that the articles are well covered and in the centre of the mass; lute the ends or top of the box with clay, and place the whole into a fire made of coke, keeping them there for an hour or more, taking care that the heat shall be equal (between dark red and red); now plunge the contents into water. Should the articles require to be blue, such as the barrels or chambers of pistols, repolish them on an emery wheel, and put them into a sand bath or powdered charcoal, until the blue colour is attained, taking them out immediately this change takes place. The following are mixtures that will do instead of the burnt leather:—3 parts of prussiate of potash to 1 sal ammoniac; or 2 parts sal ammoniac, 2 bone-dust, 1 prussiate of potash. Bones, urine, and night-soil, are also used for this purpose. A simple method of casehardening iron is to sprinkle powdered prussiate of potash over it at a red heat and plunge into water; bicromate of potash, with the pith of rams' horns, may be used with good results, instead of the prussiate.

To Clean Pearls.—Soak them in hot water in which bran has been boiled, with a little salts of tartar and alum, rubbing gently between the hands when the heat will admit of it. When the water is cold renew the application till any discoloration is removed, rinse in lukewarm water; lay them on white paper in a dark place to cool.

To Clean Marble, Jasper, Porphyry, &c.—Mix up a quantity of the strongest soap-lees with quicklime, to the consistence of milk, and lay it on the stone for twenty-four hours; clean it afterwards, and it will appear as new.

This may be improved by rubbing afterwards with fine putty powder and olive oil.

Cleaning Alabaster.—Strong soap and water is good for cleaning alabaster; if too much discoloured make a paste with quicklime and water, cover the article well with it, and let it remain all day; wash off with soap and water, rubbing hard the stains. Or supply dilute muriatic acid, having previously washed off dirt and grease.

To Clean Pictures.—Wash with a sponge or a soft leather and water, and dry by rubbing with a silk handkerchief. When the picture is very dirty, take it out of its frame, procure a clean towel, and making it quite wet, lay it on the face of the picture, sprinkling it from time to time with clear soft water; let it remain wet for two or three days; take the cloth off and renew it with a fresh one; after wiping the picture with a clean wet sponge, repeat the process till all the dirt is soaked out; then wash it well with a soft sponge, and let it quite dry: rub it with some clear nut or linseed oil. Spirits of wine and turpentine may be used to dissolve the hard old varnish, but they will attack the paint as well as the varnish if the further action of the spirits is not stopped at the proper time by using water freely.

Cleaning the Hands.—For cleaning the hands when stained with chemicals:—Put ¼ lb. glauber salts, ¼ lb. chloride of lime, and 4 oz. of water into a small wide-mouth bottle, and when required for use pour some of the thick sediment into a saucer, and rub it well over the hands with pumice-stone or a

nail brush. Stains of nitrate of silver may be removed from the hands by means of a solution of chloride of iron.

To Clean Plate.—Take an ounce each of cream of tartar, muriate of soda, and alum, and boil in a gallon or more of water. After the plate is taken out and rubbed dry, it puts on a beautiful silvery whiteness. Powdered magnesia may be used dry for articles slightly tarnished, but if very dirty it must be used first wet and then dry.

To Clean Brass or Copper.—Take 1 oz. of oxalic acid, 6 oz. rottenstone, ½ oz. gum arabic, all in powder, 1 oz. sweet oil, and sufficient of water to make a paste. Apply a small portion, and rub dry with a flannel or leather.

Cleaning Brass Inlaid Work.—Mix tripoli and linseed oil, and dip felt into the preparation. With this polish. If the wood be rosewood or ebony, polish it with finely-powdered elder ashes, or make a polishing paste of rotten-stone, a pinch of starch, sweet oil, and oxalic acid, mixed with water.

Silver Cleaning Liquid.—Prepared chalk, 8 oz.; turpentine, 2 oz.; alcohol, 1 oz.; spirits of camphor, 4 drachms; liquor of ammonia, 2 drachms. Apply with a sponge and allow to dry before polishing. Or use a solution of cyanide of potassium, 12 oz. cyanide to 1 quart water; immerse the silver, brush it with a stiff brush until clean, wash and dry.

Cleaning Steel Articles.—Unslacked lime is a capital thing to clean steel articles with. If steel ear-rings, brooches, &c., are kept in powdered quicklime they suffer very little from rust. They should be carefully cleaned when put away, to remove any moisture that may have collected on them by handling.

To clean swords, &c., rub them with powdered brick-dust and oil, rub dry with brick-dust, polish with crocus and leather.

Cleaning Hats.—The stains of grease and paint may be removed from hats by means of turpentine, and if the turpentine leaves a mark finish with a little spirits of wine.

Cleaning Metals.—Mix half a pint of neat's-foot oil, and half a gallon of spirit of turpentine; wet a woollen rag with some of this and put on it a little powder, made thus:—Take 2 oz. green copperas and ½ oz. subcarbonate of potash, burn these together in a clay vessel for a quarter of an hour in the fire, when it should be reduced to an impalpable powder for use. Having put the powder in the oiled part of the rag, well rub the metal; wipe off with a soft cloth, and polish with a dry leather and some more powder.

Cleaning Jewellery.—Common jewellery may be effectually cleaned by washing with soap and warm water, rinsing in cold water, dipping in spirits of any kind, and drying in warm *boxwood* saw-dust. Good jewellery only needs washing with soap and water, and polishing with rouge and a chamois leather.

Cleaning Engravings. — Put the engraving on a smooth board, cover it thinly with common salt finely pounded; squeeze lemon-juice upon the salt so as to dissolve a considerable portion of it; elevate one end of the board, so that it may form an angle of about 45 or 50 degrees with the horizon. Pour on the engraving boiling water from a tea-kettle, until the salt and lemon-juice be all washed off; the engraving will then be perfectly clean, and free from stains. It must be dried on the board, or on some smooth surface, gradually. If dried by the fire or the sun, it will be tinged with a yellow colour.

Crayons, Method of Making.—White paste, used for white crayons or for a body for other colours:—1. Washed pipe-clay and washed chalk equal parts, mix them into a paste with sweet ale made hot, and with a chip or two of isinglass dissolved in it.

2. Take the finest powder of calcined oyster-shells, sifted through muslin, mix it up with water in which a little rice and a little white sugar-candy has been boiled; according to the quantity of rice, so will be the hardness of the crayon. The quantity of sugar-candy should not be more than the size of a filbert-nut to a pint of water.

3. Take common pipe-clay in powder, mix it up into a paste with very strong soapsuds, made thus:—Cut up an ounce of white soap into small shavings, dissolve it over the fire in ½ pint of water, stir into the mixture while hot the powdered pipe-clay as long as you can stir it. Spirits of wine added before the powders to render the soap-water transparent, is an improvement.

4. Take 3 oz. of spermaceti, dissolve it in 1 pint of water, stir into it a quantity of fine-sifted or washed white colour till of a proper consistence. If to be mixed with dark powders, a very little ox-gall is an improvement.

5. Melt 3 oz. of shellac in 2 oz. of spirits of wine, this will form a thick liquid; to this add 6 parts of pipe-clay and 1 part of oil of turpentine; grind all well together. The lighter the colour of the shellac the better; also if colours are to be added they should be ground up with the turpentine, before this is added to the rest.

The great object of attention is to procure the white chalk or pipe-clay without grit. To accomplish this, take a large vessel of water, put the whiting into it and mix well, pour off the top into another vessel, and throw the gritty sediment away; repeat several times. When this is done, let the whiting settle, and then pour the water from it and dry it for use.

The compositions for white crayons and the requisite colours being prepared, and that chosen made up into a stiff paste, it is to be placed upon a smooth slab of marble slightly oiled. The paste is rolled out with a rolling pin, then cut into slips and these rolled into cylinders by the aid of a little flat piece of wood, then cut to the length of 3 inches each, and placed in a slow oven or drying stove to become hard.

Instead of rolling the composition, it may be forced through the nozzle of a tin funnel, this is better for the delicate colours than rolling them; when dry they may be pointed.

It will always happen that except in black or white crayons, the colour alters very much in drying, so that in mixing an allowance must be made for this effect.

Crayons, Colours for.—*White.*—The best whites to employ are whiting or prepared chalk, pipe-clay, alum white or alumina, oyster-shell white, calcined bones, &c.

Carmine and Lake.—Crayons of these colours are generally hard; when made with powdered colours, the proper way of mixing is to dissolve the colour first in water or spirits of wine, and add it to nearly-dry white colour, grinding the whole well together. There should be four or five shades—madder is not used.

Vermilion and Red Lead, Red Ochre, Indian Red.—Each of these may be well ground in water, and when wet, mixed well with the white in different shades. These will make various reds, as well as salmon colour, flesh colour, orange Hæmatite or crocus, of itself, ground and mixed with a little size, forms an excellent crayon.

The square chalks, or crayons, are made of the mineral red chalk, or ochre cut into slips with a saw. The same material is used in pencils for carpenters and others.

Yellows.—Dissolve the colours, which are Naples yellow, King's yellow, and yellow lake, in spirits of wine, and mix as for carmine. The chrome yellows are not so useful, because less durable. Gamboge, Indian yellow, and gall stone are not employed, but the various yellow ochres make good crayons.

Blue.—A good soluble colour is Prussian blue, but it is hard to grind. Dissolve it in water, then put the solution in a hole cut in a piece of chalk, this will absorb the water, and leave a great portion of the colour ready for mixing. Blue verditer is a good bright colour, but is so gritty as to require washing, as recommended for whiting. The same may be said of smalts or cobalt.

Browns.—These are Cologne earth, umber, raw and burnt; sienna, raw and burnt; treated as the blue.

Greens.—These may be either simple colours, as emerald green, Prussian green, green carbonate of copper; or better formed by adding the compositions of

the yellow and blue crayons together. Raw and burnt sienna may also be used in combination with Prussian blue or indigo. Good green crayons are more difficult to make than those of any other colour.

Black.—Chalk or charcoal is first to be sawed in 3-inch lengths, free from knots; then saw them longitudinally in narrow strips. Procure a tin trough about 4 inches by 3, and partly fill it with white wax; and after properly melted, the pieces of charcoal are to be saturated for forty-eight hours, and after draining they are fit for use. When white paste is employed the only powdered colour to be used is lampblack, all the others are apt to get mouldy.

Mixed Colours.—Mixed or half colours are produced by an admixture of the colours required in the paste. Thus a combination of blue and carmine produces a purple; the yellows and red united form orange; black and carmine is a beautiful tint for shading; vermilion and black form a fine rich brown; green and brown form an olive colour; and red and brown a chocolate.

CRAYONS FOR DRAWING ON GLASS.—Melt together equal quantities of asphaltum and yellow wax; add lampblack, and pour the mixture into moulds for crayons. The glass should be well wiped with leather, and in drawing be careful not to soil the glass with the fingers. In trimming these crayons, if the edge be bevelled, like scissors, the point may easily be rendered very fine.

Dyeing Silk.—For dyeing purposes we may consider that a pound of silk woven into common sarsenet, measures about 13 yards: this multiplied by 16, gives 208; or for a more convenient standard, we may calculate 200 yards at 16 lbs., 100 at 8 lbs., and so on.

JET BLACK *from Nitro-Sulphate of Iron.*—For 200 yards or 16 lbs. Prepare in a hot solution of nitro-sulphate of iron, 5° Twaddle, 150° Fahrenheit; work 30 minutes in this; lift, and wash well in 3 warm waters; then boil 18 lbs. of fustic; put off the boil; enter, and winch for 30 minutes; lift · boil 16 lbs. logwood, put off the boil, and decant the clear liquor into a large tub; add 1 lb. of white soap; enter, and winch for 30 or 40 minutes in this; lift; wash in 2 waters, and you will have a brilliant jet black.

JET BLACK *from Nitrate of Iron.*—For 200 yards. After being cleaned, prepare in a cold solution of nitrate of iron, 5° Twaddle (this is strong enough for light silks, 4° or 4½° will do for dark and dipping silks); 30 minutes in this; lift; boil 14 lbs. fustic; put off the boil; enter, and winch 30 minutes; lift; wash in 3 waters, blood-warm; then boil 16 lbs. logwood; decant as before; give the same quantity of soap, and finish in the same way.

BLACK *from Sulphate of Iron.*—For 200 yards. After being cleaned or scalded, discharge in a hot vitriol sour; a cold and then a warm water out of the sour; run through another scald, and 2 warm waters; then boil 14 lbs. fustic; put off the boil; winch 30 minutes, and lift for saddening; make up a solution with some of the fustic left in the last process, and 1 lb. copperas; winch in this for half an hour; wash in 3 waters; dye with 16 lbs. logwood and 1 lb. of soap.

HAT BLACK.—Work 5 lbs. silk in a mixture of 2 lbs. fustic chips; 1 lb. quercitron bark; lift; then add 6 oz. verdigris, 6 oz. copperas; work for quarter of an hour, and hang up all night; wash and dye with a decoction of 5 lbs. logwood with as much white as will make a lather.

DYEING SHOTS.—When satins, satinets, sarsenets, or silks of any kind are found to contain shots, that is, *warp and weft of different qualities*, they must be prepared as follows:—For 100 yards. Dissolve 1½ lb. salt of tartar in a copper containing 150 gallons boiling water; winch in this one hour; lift, and wash in 2 waters; and then prepare for any colour. If, after dyeing black, brown, or any colour, the silk is found to contain a shot of different silk, it must be discharged to the bottom, and put through the stuff as directed above; then prepare a new, for whatever colour required.

CINNAMON BROWN.—For 100 yards.

Boil 12 lbs. fustic; 3 lbs. ground madder, 2 lbs. barwood. Cool to 200° Fahrenheit, then enter, and winch 20 minutes; air out, and repeat; with a little of the liquor in another dish, sadden to pattern with 4 or 5 oz. copperas, 1 or 2 shots; wash in 2 waters, and dry.

Olive Brown.—For 10 yards. Boil fustic, 1 lb.; logwood, 3¼ oz.; cudbear, 2½ oz. Cool to 200° Fahrenheit; enter, and winch for 20 minutes; air out; repeat; sadden to pattern with 4 oz. copperas; wash and dry.

French Brown.—Prepare in a hot solution of alum, for 10 or 12 hours; lift, and wash in 2 waters; boil or scald. For 10 yards. Limawood, 1 lb.; ground fustic, 4¾ oz. Decant the clear of both liquors into another dish; enter, and winch for 30 minutes; air out, and repeat; if dark enough, wash in 2 waters, and dry. Common brown is done in this way by adding a little logwood.

In preparing this and the following colour, a little copperas is sometimes used along with the alum; when done in this manner, raise slightly with muriate of tin.

Claret.—Prepare with alum like the last; boil or scald. For 10 yards. Limawood, 1¼ lb.; logwood, 3¾ oz. Decant the clear of both liquors into a tub of sufficient size; enter, and winch for 30 minutes; air out, and repeat; when dark enough, wash and dry.

In dyeing the two last, they ought to get two liquors, or the liquor at twice, as one will hardly make the colour as full as it ought to be.

Pale Blue.—For 100 yards. 3 oz. paste or extract of indigo; 6 oz. tartaric acid. Sour first in a hot solution of sulphuric acid (about 1½ gill), lift, and wash in 1 water. Prepare the paste and dissolve the acid in a little hot water; then take a copper or stoneware vessel of sufficient size, fill it nearly full of water, 110° Fahrenheit; put in the paste, and 5 parts of the tartaric acid; winch in this 15 minutes; lift; wash in cold water; harden with the part of tartaric not used; lift, and dry.

In dyeing printed silks, containing black or any colour you wish to retain, they must not be soured in dyeing, and use as little raising as possible.

To Prepare Extract of Indigo.—Every particle must be well broken with a palette knife, or the back of a tablespoon, after which pour on a little boiling water; stir it up, and let it settle for a little before using.

Royal Blue.—Prepare in a solution of nitrate of iron, 3° Twaddle, 100° Fahrenheit; and for every pound of prussiate used in dyeing, add as much of the crystals of tin (dissolved in hot water) to the preparation; work in this till the silk turns a light buff colour; lift, and wash in 1 water; after which, for 100 yards, dissolve 4 lbs. prussiate of potash in a little boiling water; put this into a copper containing 80 gallons water, 120° Fahrenheit; add 1½ gill sulphuric or muriatic acid; enter in this; winch 15 minutes; lift; 1 water; run again through the preparation; add 2 gills sulphuric acid to the prussiate; repeat in it, and if not dark enough, lift, and add a little nitrate of iron; after getting it to the required shade, give 2 waters; then harden in a solution of alum; and dry in a hot stove.

Pea Green.—For 100 yards. 10 oz. extract of indigo, 2½ lbs. ebony, 1 lb. alum. Sour first; wash in 1 water; boil or scald the ebony; decant the clear into another dish, and add the extract of indigo and alum; enter in this, and winch for 10 or 15 minutes; wash in 1 water.

Common Pale Green.—For 11 yards. Extract of indigo, 2 oz.; ebony, 1¾ oz.; alum, 1¾ oz.; sulphuric acid, 1¼ oz. Work as for Pea Green.

Grass Green.—For 10 yards. Fustic, 12 oz.; extract of indigo, 3 oz. 3 drachms; alum, 3 oz. 3 drachms; sulphuric acid, 1½ oz. Boil the fustic first; then add the extract of indigo, alum, and acid; put off the boil; enter and winch till you get the shade required; if not blue enough, give more extract of indigo; if not yellow enough, more fustic.

Myrtle Green.—For 10 yards. Fustic, 1 lb.; logwood, 3 oz. 3 drachms; extract of indigo, 3 oz. 3 drachms; bluestone, ½ oz. Boil the logwood and fustic

together; put off the boil; enter; winch 20 minutes; air out and repeat; raise with 3 oz. bluestone dissolved in the boiler; then give the extract of indigo; 1 water; rince in the remaining 2 oz. bluestone; harden in a solution of alum, and dry.

OLIVE GREEN.—For 100 yards. 10 lbs. fustic, 2 lbs. logwood, 10 oz. camwood. Boil altogether for 30 minutes; put off the boil; enter and winch for 20 minutes; air out and repeat; sadden with 3 or 4 oz. copperas in the same liquor, or with a little of the liquor in another dish; when the required shade is got, wash and dry.

DRAB.—For 100 yards. Boil 4 lbs. fustic and 6 oz. logwood; 2½ oz. cudbear; 1¼ oz. copperas. Cool to 200° Fahrenheit; enter; winch 20 minutes; air out; repeat; then take a little of the liquor out of the boiler, dissolve the copperas, reduce it to handling heat with water, and give 1 or 2 shots through it as the pattern requires; 1 water out of the saddening; then give a warm, but weak sour, to clear the colour; wash in 2 waters, and dry.

Before using cudbear, it must always be drenched with a little hot water, to the consistency of paste; then scald or boil it as occasion may require.

FAWN.—For 10 yards. Fustic, 6½ oz.; cudbear, ½ oz.; copperas, 1½ drachm. Use as for Drab.

STONE.—For 100 yards. 3 lbs. fustic, 7½ oz. logwood, 2½ oz. cudbear, 2 oz. copperas. Use as for Drab.

SLATE.—For 100 yards. 8 oz. cudbear, 2 lbs. logwood, 1 lb. tartar. Bottom with the cudbear; lift; boil the logwood; decant into a tub of sufficient size; enter and winch in this for 15 minutes; lift and raise with the tartar at twice, then wash and dry.

STRAW.—For 10 yards. Annatto, 6½ drachms; barks, 1¼ oz.; muriate of tin, 1½ oz. Give the annatto on the bottom 212° Fahrenheit; 1 water out, and then give the barks and muriate of tin, same heat.

Before using annatto, it must be boiled with half its weight of American ashes, in the least possible quantity of soft water. This applies to every process where annatto is used.

BUFF.—For 10 yards. Annatto, 1½ oz.; vitriol, 1½ oz. Give the annatto at 212° Fahrenheit; when full enough, lift; wash in 2 waters; then raise with the vitriol.

CREAM COLOUR.—For 10 yards. Boil annatto, 9½ drachms; vitriol, 1 oz. Work in the same manner as Buff.

CHAMOIS.—For 10 yards. Annatto, 9½ drachms; fustic, 6½ oz.; madder, 6½ drachms; cudbear, 3½ drachms. Bottom with the annatto, 212° Fahrenheit; wash in 1 water; boil the fustic, madder, and cudbear together; put off the boil, and enter; winch 15 minutes; if not full enough, air out and repeat; then wash and dry.

SALMON COLOUR.—For 10 yards. Annatto, 1¼ oz.; cudbear, 4 drachms. Boil the annatto; then add the cutbear; put off the boil; enter and winch 30 minutes; wash in 2 waters; then dry.

ORANGE.—For 10 yards. Annatto, 1⅔ oz.; bark, 1¼ oz.; muriate of tin, 1½ oz. Give a good body of annatto, 212° Fahrenheit; wash in 1 water; then top with the bark and muriate of tin.

AMBER.—For 10 yards. Annatto, 1½ oz.; bark, 1¼ oz.; muriate of tin, 2½ oz. Bottom with the annatto, and top with the bark and muriate of tin. Use as for Orange.

PINK.—For 10 yards. Bottoming, blue archil, ½ oz.; dyeing, safflower, 2 oz.; raising, tartaric acid, ½ oz. Put the archil into 100 gallons boiling water; winch in this 15 minutes; lift; bleed; then refine the safflower with cotton; make up a safflower liquor of 100 gallons; enter and winch 15 minutes; lift; put in half the raising; return and winch 10 minutes; lift again and add the other half of the raising; return for 10 minutes more; then wash in 1 water; harden with a little tartaric in another, and dry.

Rose colour may be made in this way, by giving more stuff.

TO PREPARE SAFFLOWER.—Steep 2½ lbs. safflower all night in water; in the morning rub the cakes between the hands, so that it may be all broken; then put it into a bag or close sieve; stand with it under a good run of water

until the particles are all disengaged from each other, and purged of impurities; then put 20 or 30 gallons of water into a large tub, add ½ lb. soda dissolved, and put in the safflower; stir it up, and let it bleed 30 or 40 minutes; then strain it through the bag into a second tub; if not well enough bled, repeat in the first tub with a little more soda. To refine safflower after being bled, —immerse 3 or 4 lbs. cotton yarn or cloth in it; in 10 minutes lift, and add a little tartaric; return for 10 minutes; add a little tartaric again; return for 10 minutes more; lift, and add the tartaric a third time, at which time it must do no more than taste slightly sour; then wash in 2 or 3 waters, after which it must be bled in a tub of clean water with a little soda; then make up this liquor with water for dyeing.

Rose Colour with Cochineal.—For 10 yards. Bottoming, blue archil, ¾ oz.; preparation, tartar, ¾ oz.; scarlet spirits, 2½ oz.; dyeing, cochineal, fully 1½ oz. Bottom with archil; lift; dissolve the tartar, and put it and the spirits into 100 gallons water; winch in this for some time; then let it lie 12 hours (if this preparation is made hot, 3 or 4 hours will do); pound, and then boil the cochineal; put off the boil; lift out of the preparation, and enter; winch till the liquor cools, and the colour will be full enough.

Scarlet with Cochineal.—For 10 yards. Bottoming, annatto, fully 1½ oz.; preparation, tartar, 1¼ oz.; scarlet spirits, 3½ oz.; dyeing, cochineal, 2½ oz. Bottom with the annatto, 212° Fahrenheit; winch 15 or 20 minutes, and it should be a full orange; then give the preparation and cochineal as for rose colour.

Fast Crimson.—For 10 yards. Bottoming, cudbear, 1½ oz.; preparation, tartar, 1¼ oz.; scarlet spirits, 3½ oz.; dyeing, cochineal, 2 oz. Boil or scald the cudbear; winch in this 30 minutes; then prepare and dye as before.

Purple.—The best purples are made upon the purple vat. For a red shade, wash in 2 cold waters; for a blue shade, wash in 2 hot waters. Another but inferior method is, to prepare with alum, dye with logwood, and raise with double muriate of tin.

Royal Blue Purple.—For whatever depth of colour required, winch upon the purple vat, wash in 2 warm waters; then put a little extract of indigo into a tub of cold water; add a little sulphuric acid; enter and work in this till you get the required shade, then wash in cold water, and dry

Lilac.—The best lilac is dyed upon nitro sulphate of iron spirits, when without these, the following is the simplest method: 10 gallons water, 1 pint purple vat. Add raw muriatic acid till the glass stands at 6° Twaddle; enter in this, and work till you get the required shade; if too light, add more purple liquor, wash in 2 warm waters, and dry.

Lavender.—Same as lilac, by adding a little neutralized extract of indigo. Break 4 oz. of extract of indigo; dilute it with 2 quarts of hot water, and add half an ounce of soda, to destroy or neutralize whatever acid the extract contains; after stirring it well up, let it stand for two days, then strain it for use. Silver grey gets less stuff than lavender.

Aniline Colours.—No mordant is necessary for these colours when used on silk or woollen; the proper quantity of clear liquid is mixed with slightly warm water, the scum formed skimmed off, and the goods entered and worked until the required shade is obtained. Paste mauve is dissolved in spirit before being used, and care must be taken to prevent irregularities from the tarry scum. For dyeing on cotton, the cloth is steeped in sumac or tannic acid dyed in the colour, and can then be fixed by tin; or the cloth may be sumaced and mordanted as usual with tin, and then dyed.

Woollen Dyeing.—A pound of wool woven into common merino measures about 3 yards, common moreen about 2 yards.

Jet Black.—For 50 lbs. Prepare with 2¼ lbs. chrome; boil half an hour, and wash in 2 waters. Dye with 20 lbs. logwood and 2 lbs. fustic. Boil half an

hour; 1 water, then a slight sour, moderately warm; 1 cold water, and finish out of a warm one, softened with a little urine.

Geneva Black.—3 lbs. green copperas, 3 lbs. tartar, ½ lb. sulphate of copper, 1 lb. fustic, 1 lb. logwood. Boil for half an hour; enter, and boil the cloth 3 hours; wash; then enter into a vat with 11 lbs. logwood; boil 1 hour; raise; enter into logwood vat for half an hour, and finish.

Fast Black.—For 50 lbs. Prepare with 2 lbs. chrome, 1 lb. tartar, and 1 quart muriate of tin; boil 1 hour, and wash in 2 waters. Dye with 25 lbs. logwood and 3 lbs. fustic. Boil 30 minutes, lift, add 1 pint vitriol. Return for 10 minutes, then wash and dry. To render this *blue-black*, omit the fustic.

Cinnamon Brown.—For 50 lbs. 8 lbs. fustic, 2 lbs. madder, 10 oz. cudbear, 1 lb. tartar, 2 lbs. alum. Give 2 runs, and sadden with 3 or 4 oz. of copperas.

French Brown.—For 50 lbs. Preparation, 1½ lb. chrome. Dyeing, 6 lbs. fustic, 1 lb. ground madder, ½ lb. cudbear, 1 lb. tartar; and if not dark enough, add 8 oz. logwood. Boil half an hour.

Claret.—For 50 lbs. Preparation, 1½ lb. chrome. Dyeing, 9 lbs. limawood, 2 lbs. logwood, ½ lb. tartar. Boil half an hour.

Olive Brown.—For 50 lbs. Preparation, 1½ lb. chrome. Dyeing, 7 lbs. fustic, 3 lbs. madder, 1 lb. logwood, 2 lbs. tartar, 8 oz. cudbear. 2 run; raise in the second with 5 or 6 oz. bluestone; wash well and dry.

Common Dark Brown.—For 40 lbs. 6 lbs. logwood, 12 lbs. redwood, 4 lbs. madder. Boil half an hour, air out and repeat, then sadden with 1 lb. copperas; if too dark, raise to pattern with muriate of tin.

Ruby.—For 50 lbs. Preparation, 3 lbs. tartar and 2 lbs. alum. Boil half an hour, and wash in 3 warm waters. Dyeing, 8 lbs. limawood, ½ lb. cudbear, and ¾ lb. tartar. Boil half an hour, and blue to pattern with hot water.

Purple.—For 50 lbs. Preparation, 1½ lb. tartar and 1 lb. alum; wash in 3 waters. Dye with 10 lbs. logwood; boil half an hour; raise with 1 quart muriate of tin.

Royal Purple.—For 50 lbs. Blue on the woad vat, either warm or cold, for whatever depth of colour required; wash in 2 waters; then give 2½ lbs. cudbear; boil half an hour, or until you get the shade wanted; if not blue enough, give another run upon the vat.

Pale Blue.—For 50 lbs. 1 gill sulphuric acid, 3 oz. extract of indigo, 1 lb. alum. Enter cold with one half of the extract; give the other half when the boiler warms; bring to the spring.

Royal Blue.—For 56 lbs. 3½ lbs. super-sulphate of tartar, 3½ lbs. prussiate of potash, 2 lbs. 10 oz. logwood, 3½ quarts royal blue spirits, 3½ pints muriate of tin. Into a boiler containing 100 gallons of water, put the prussiate and super-sulphate of tartar, after being dissolved in a little boiling water; have the logwood boiled beforehand, put it in, and one-half of the blue spirits; enter cool, heat up to 180° Fahrenheit, and lift; give the rest of the blue spirits; return and boil for a quarter of an hour; lift again, cool well and give the muriate of tin; return and boil 15 minutes; lift, wash, and dry.

Royal Blue Purple.—For 56 lbs. 10½ lbs. logwood, 1½ lb. prussiate of potash, 3½ lbs. super-sulphate of tartar, 3½ quarts royal blue spirits, 3½ pints muriate of tin. Give the logwood at twice lest the colour get unlevel.

Pea Green.—For 54 lbs. 2 lbs. extract of indigo, 7 lbs. fustic, 1 lb. alum. Bring on from the cold; when the boiler heats to 180° Fahrenheit, put in the fustic; boil 15 minutes.

Common Pale Green.—For 50 lbs. 3½ lbs. extract of indigo, 2½ lbs. fustic, 10 oz. tartar, 1 gill sulphuric acid. Give the extract and acid first; when at 180° Fahrenheit, put in the fustic and tartar; boil 15 minutes.

Grass Green.—For 50 lbs. Boil 20 lbs. fustic, 7 lbs. extract of indigo, 1½ lb. tartar, 3 gills sulphuric acid.

Olive Green.—For 50 lbs. Prepare with 1½ lb. chrome; boil half an hour, and wash in 2 waters; then boil 12 lbs. fustic and 2½ lbs. logwood for 1

hour; add 2 lbs. madder and 2 lbs. redwood. Enter; boil half an hour. Raise in the same liquor with 4 oz. bluestone; wash well and dry.

PEACH.—For 50 lbs. Drench 8½ lbs. cudbear with a little hot water; boil or scald it in 3 or 4 gallons; decant the clear liquor into a boiler containing 100 gallons water; enter cold; bring to the boil; lift and put in 1 lb. soda, or 2 gallons urine; return and boil 10 minutes.

DRAB.—For 50 lbs. 7 lbs. fustic, 8 oz. madder, 4 oz. cudbear, 2 lbs. alum, 8 oz. tartar. Enter between the cold and 160° Fahrenheit; after heating up, boil from 10 to 30 minutes; wash in 2 waters. All dark shades of this and the four following colours may be slightly prepared with chrome; wash in 2 waters.

LIGHT DRAB.—For 56 lbs. 4 lbs. fustic, 1¾ lb. alum, 4 oz. madder, 4 oz. tartar, 3½ oz. cudbear. Work as for drab.

FAWN.—For 50 lbs. 5 lbs. fustic, 1 lb. madder, ½ lb. camwood, ½ lb. cudbear, 2 lbs. alum. Work as for drab.

STONE.—For 50 1 lb. logwood, 4 oz. fustic, 8 oz. extract of indigo, 3 lbs. alum, 1½ lb. tartar. Work as for drab.

SLATE.—For 50 lbs. 1 lb. logwood, 8 oz. extract of indigo, 4 oz. fustic, 2 lbs. tartar, 2 lbs. alum. Work as for drab.

STRAW.—For 50 lbs. Boil 3½ lbs. quercitron bark and 3 oz. cochineal. Add 2½ lbs. tartar, 3 quarts muriate of tin. Enter at 150° Fahrenheit; boil 30 minutes.

PRIMROSE.—For 50 lbs. Boil 2½ lbs. bark. Add 2 lbs. tartar, 2 quarts muriate of tin. Enter at 150° Fahrenheit; boil 30 minutes.

YELLOW.—For 40 lbs. 2½ lbs. bark, 2 lbs. tartar, 2 quarts muriate of tin. Enter at 150° Fahrenheit; boil 30 minutes.

BUFF.—For 45 lbs. Boil 4½ lbs. fustic and 1½ lb. madder. Add 7 lbs. alum. Enter at 200° Fahrenheit; boil 30 minutes.

AMBER.—For 40 lbs. Boil 4 lbs. bark and 8 oz. madder. Add 2 quarts muriate of tin, 1 lb. tartar. Enter at 200° Fahrenheit; boil 30 minutes.

ORANGE.—For 50 lbs. Boil 10 lbs. bark and 1½ lb. cochineal. Add 2 lbs. tartar, 2½ quarts yellow spirits. Enter at 200° Fahrenheit; boil 30 minutes.

LILAC.—For 50 lbs. Boil 5½ lbs. logwood and 2 lbs. alum. Add 2 quarts muriate of tin, 8 oz. extract of indigo. Brought on from 100° Fahrenheit.

LAVENDER.—For 45 lbs. Boil 2 lbs. logwood and 2 lbs. alum. Add 10 oz. extract of indigo. Enter cold, and bring up to the boil.

FRENCH GREY.—For 50 lbs. Boil 7 lbs. fustic and 12 oz. cudbear. Add 6 oz. extract of indigo, 1 pint sulphuric acid. Cool to 180° Fahrenheit; enter, and boil 20 minutes.

SILVER GREY.—For 50 lbs. Boil 1 lb. logwood and 2½ lbs. alum. Add 5 oz. extract of indigo. Brought on from 100° Fahrenheit; boil 10 minutes.

FRENCH PINK.—For 50 lbs. 3 gills ammonia paste; 1½ lb. tartaric acid, to redden; 10 oz. oxalic acid, to blue. Enter at 140° Fahrenheit; heat no higher than 200°.

ROSE COLOUR.—For 40 lbs. 1 lb. cochineal, 3 gills double muriate of tin, 1 lb. tartaric acid. Enter at 100° Fahrenheit; heat up; boil 15 minutes; lift, and cool to 120°, by throwing out part of the liquor, and filling up with water,—add 1 gill ammonia paste, 12 oz. tartaric acid, 6 oz. oxalic acid. Bring up to the boil; when the desired shade is got, wash well, and dry.

SCARLET WITH COCHINEAL.—For 50 lbs. Boil 4 lbs. cochineal and 1¾ lb. bark. Add 3 lbs. tartar, 2 quarts scarlet spirits. Enter at 200° Fahrenheit; boil one hour; wash well. Sour before dyeing, either cold or warm; 1 water, out.

SCARLET WITH LAC.—For 50 lbs. Boil 5½ lbs. lac and 1½ lb. bark. Add 3 lbs. tartar, 2 quarts lac scarlet spirits. Enter at 200° Fahrenheit; boil 1 hour; wash well. Sour as before.

SCARLET WITH LAC AND COCHINEAL.—For 50 lbs. Boil 4½ lbs. lac and 1¾ lb. bark. Add 2 lbs. tartar, 2 quarts lac scarlet spirits. Enter at 200° Fahrenheit; boil in this 30 minutes; lift, and wash well; then, in a boiler of clean

water, boil 14 oz. cochineal and 14 oz. tartar. Add 1½ pint scarlet spirits. Enter at 200° Fahrenheit; boil 20 minutes, and wash well out. Sour before dyeing.

LIMAWOOD CRIMSON. — For 50 lbs. Prepare with 2 lbs. alum and ½ lb. tartar. Boil half an hour; wash in 3 warm waters. Boil in 11 lbs. limawood, and add ½ lb. cudbear. Boil in this for half an hour, and blue with warm water.

FAST CRIMSON.—For 50 lbs. 6¼ lbs. cochineal, ½ lb. cudbear. Boil in this three-quarters of an hour; raise with 2 quarts crimson spirits; boil a quarter of an hour; lift, wash well, and dry.

COCHINEAL CRIMSON. — For 50 lbs. 3½ lbs. cochineal, 2½ lbs. tartar, 2 quarts crimson spirits. Boil half an hour; wash well; blue with urine or a little ammonia, in a clean tub of warm water, 150° F.

Cotton Dyeing, BLACK.—For 40 lbs. Boil or scald 10 lbs. sumac; lay the cloth or yarn in this for 18 hours; wring out; run through acetate of iron, 40° Twaddle; 4 turns, or for half an hour; wring out; repeat and wash well in 3 waters; then boil 8 lbs. logwood and 1 lb. fustic; put off the boil and enter; or the clear of the liquor may be decanted into another dish; 1 run, continue half an hour; wring out; repeat; sadden with 1 lb. copperas; 2 runs; wash and dry. In Job Dyeing, for a piece of cloth 20 yards, prepare in strong hot sumach like the above; then put 3 quarts slacked lime into 20 gallons water; when the lime precipitates, decant the clear into another tub, lift the cloth out of the sumach, give 1 run through acetate of iron, 1 through lime, repeat in the iron, and again through the lime. Should the cloth have got unlevel, give an extra run through the lime to make it level; then wash in 2 waters, and give logwood and a little fustic, like the above.

FAST BLACK. — For 50 lbs. Dark blue on blue vat *cotton;* lay then in 18 lbs. hot sumach for 24 hours; lift, and sadden with black iron liquor; wash and dry.

BROWN.—For 50 lbs., or 200 yards. Prepare with 2½ lbs. sumach, acetate of iron, 2° Twaddle, and lime, 1° Twad. Dye with 18 lbs. redwood and 4 lbs. fustic. Twenty-four hours in the sumach; lift, and run through the iron tub, then through the lime; repeat in each tub, and wash in 3 waters; then scald or boil the wood; decant into another tub; enter and winch for 20 minutes; air out, and repeat; if not dark enough, add a little logwood; then sadden with 6 or 8 oz. copperas.

MADDER BROWN.—For 40 lbs. Boil or scald 10 lbs. sumach; lay the goods in it for 24 hours; lift, and decant into a tub, containing 60 gallons water, 1 quart acetate of iron, and 1 quart mordant. Enter; turn for half an hour; lift, and wash in 2 waters; then dye with 10 lbs. best crop madder; enter cold, and bring to the spring.

DARK BROWN WITH CATECHU.—For 200 yards. Boil 30 lbs. catechu; enter the cloth as it leaves the singeing-work; winch it in the catechu for some time, and let it down into the boiler all night; in the morning light a fire under the boiler; lift the cloth, and give 2 runs through acetate of iron; wash well out of the iron; have the boiler up, and give another run through it at the boil, 1 hour; lift, and give other 2 runs of iron, when it will be quite black; stripe with lime to the shade required.

LIGHT CATECHU BROWN.—For 50 lbs. Boil 20 lbs. catechu in one boiler, 5 lbs. chrome in another. Enter in the catechu first; work 20 minutes, and wring out; then through the chrome, 10 minutes, and wring out; through catechu again; giving shot about till dark enough; finishing with catechu.

CLARET.—For 50 lbs. Preparation, 12½ lbs. sumach; spirit tub, 3° Twad. Dyeing, 15½ lbs. limawood; 2 lbs. logwood, to blue. Raising, 1 quart red spirits for cotton. 8 to 10 hours in the sumach; work 1 or 2 hours in the spirit tub; wash out of it in 3 waters; boil the limawood and logwood decant into a large tub; winch 30 minutes; lift, and give the raising; enter again for 15 minutes; lift, wash, and dry.

RUBY. — For 50 lbs. Preparation,

12½ lbs. sumach; spirit tub, 3° Twad. Dyeing, 12½ lbs. limawood; 1 lb. logwood to blue. Raising, 1 quart red spirits, for cotton; wrought like *claret*.

PURPLE.—For 50 lbs. Preparation, 12½ lbs. sumach; spirit tub, 2½° Twad. Dyeing, 15 lbs. logwood. Raising, 1 quart purple spirits, cotton; wrought like claret.

SCARLET.—For 40 lbs. Preparation, 16 lbs. sumach; spirit tub, 3° Twad. Dyeing, 24 lbs. limawood, 3½ lbs. turmeric. Raising, 6 lbs. alum. After lying in sumach 24 hours, lift, and winch it in the spirit tub; wash well out; boil the wood; decant the clear liquor into a large tub; enter, and winch for 30 minutes; then raise with alum.

CRIMSON WITH COCHINEAL.—For 50 lbs. Prepare with 15 lbs. sumach and 10 lbs. alum. Dye with 6¼ lbs. cochineal. Twenty-four hours in the sumach; lift; make up a hot solution of alum; winch in that 2 or 3 hours; lift; wash in 2 waters; then boil the cochineal; put off the boil; enter, and winch till full enough; then wash and dry.

LIMAWOOD RED.—For 40 lbs. 10 lbs. sumach; spirit vat, 2½° Twaddle; 12 lbs. limawood; 1 quart red spirits. After being prepared with sumach, winch it in the spirit vat for 2 hours; lift, and wash well in 3 waters; boil or scald the limawood; decant the clear liquor into another vessel; enter, and winch in this for 30 minutes; lift, and raise in the same liquor, with 1 quart of red spirits.

BARWOOD RED.—For 40 lbs. 10 lbs. sumach; spirit vat, 2½° Twaddle; 40 lbs. barwood; 1 quart red spirits; done in the same manner as limawood red.

DRAB.—For 40 lbs. Boil 6 lbs. fustic; scald 2½ lbs. limawood; 2 lbs. sumach. Decant into a wooden vessel, capable of containing 100 gallons; reduce with cold water to handling heat; enter; 6 turns; wring out; sadden with 8 oz. copperas; 4 turns; wring out again, and give 4 oz. bluestone.

FAWN.—For 50 lbs. Boil 5 lbs. fustic and 3 lbs. limawood. Add 2 lbs. alum. Decant the fustic and limawood into a large tub; reduce to handling heat; enter and work 15 minutes; if not dark enough, add 8 oz. logwood; then wash and dry.

STONE.—For 50 lbs. Boil 4 lbs. fustic, 2 lbs. limawood, 2 lbs. madder. Decant and work in this 15 minutes; air out and repeat; lift, and add 4 or 6 oz. copperas; enter again, and work till you get the required shade; then wash and dry.

LAVENDER.—100 yards. Scald 1 lb. logwood and 2 lbs. sumach. Decant both into a tub of sufficient size; cool to 150° Fahrenheit; add 2 gills vitriol; winch in this 20 minutes; lift and run slightly through acetate of iron; wash in 2 waters, then give 1 lb. logwood as before; raise with a pint of muriate of tin; wash in 2 waters; then, in a tub of cold water, put 4 oz. extract of indigo; enter, and winch in this 15 minutes; lift, give 1 water, and dry.

LILAC.—100 yards. Scald 1½ lb. logwood, 2 lbs. sumach. Decant, and work like the last; sadden, and top with logwood; raise with muriate of tin.

PINK.—For 30 lbs. yarn, or 250 yards cloth. Bleed 7 lbs. safflower in 50 gallons soft water; dissolve 2 lbs. tartar in 3 gallons hot water; enter the yarn in the safflower, and give 4 turns; lift, and put in one-half of the tartar; enter; 4 turns more; lift again, and put in all the tartar, and work in it till you get the required shade.

DEEP BLUE.—Put 10 lbs. cotton through the *blue vat;* soak in a decoction of 2 lbs. sumach for 3 hours; work for 15 minutes through water containing 1 pint red mordant and 1 pint black liquor; wash twice in hot water, then work 20 minutes in a decoction of 2 lbs logwood; lift, and raise with ½ pint of red mordant, work 10 minutes; wash and dry.

PALE BLUE.—For 50 lbs. 2½ lbs. prussiate of potash; nitrate of iron, 3° Twaddle; add 2½ lbs. crystals of tin, 1 pint vitriol. Turn in the iron tub 20 minutes; lift; run through cold water (not rinced), wring up; shake well out. dissolve the prussiate into 100 gallons water; enter, and winch 15 minutes;

lift, and give 2 gills vitriol; return for 10 minutes; lift, and run through water; again through the iron tub; repeat in the prussiate; raise again with vitriol, and when the required shade is got, lift; 1 water, and finish out of a weak solution of alum.

ROYAL BLUE.—Run upon the cold blue vat, *cotton;* air out; wash in 2 waters, and sour; then give a run through the iron (nitrate) tub; 1 water, and top with prussiate of potash, ½ an ounce to the pound of yarn. If the vat is not in good order, or without that convenience, better do this colour with prussiate altogether.

ORANGE.—For 40 lbs. 2½ lbs. annatto, 24 lbs. bark, 3 quarts muriate of tin. Boil the annatto; put off the boil; enter, and winch till it has a good body; wring out, wash well, wring again, and shake out; then, in a clean boiler, boil the bark in a bag for 15 minutes; add the muriate of tin, and enter; winch at the spring till the required shade is got.

ORANGE YELLOW. — For 50 lbs. Bottoming, 1½ lb. annatto. Dyeing, 5 lbs. bark, 3 quarts muriate of tin. Give the annatto boiling hot; wash in 2 waters; boil the bark, and add the muriate of tin; enter; winch 20 minutes, then wash and dry.

CHROME YELLOW. — For 50 lbs. 10 lbs. acetate of lead, 5 lbs. chrome. Dissolve separately, and put each into a tub containing 100 gallons water; enter in the lead first, 4 or 5 turns; wring out; then through chrome; continue from the one to the other till dark enough.

OLIVE.—For 50 lbs. 10 lbs. bark, 2 lbs. logwood, 8 oz. bluestone. Boil the bark in a bag; put off the boil, and enter; winch 20 minutes; lift, and put in the bluestone; return for 10 minutes; lift and wash in 2 waters, and top; give the logwood in another dish; when dark enough, wash and dry.

BUFF.—Give nitrate of iron, 6° Twaddle, 150° Fahrenheit; winch in this till full enough, then lift; give 2 waters; raise in a solution of lime, 1° Twaddle; if not dark enough, repeat in the iron tub, then in the lime.

GREEN.—For 40 lbs. Preparation, nitrate of iron, 4° Twaddle. Dyeing, 1½ lb. prussiate of potash, 45 lbs. fustic, 8 oz. extract of indigo. Raising, 1 pint vitriol, 5 lbs. alum. Turn in an iron tub for 20 minutes; wring out; run through cold water lightly, wring and shake well out; dissolve the prussiate; put it into a tub of cold water, 4 or 5 turns; lift, and give 2 gills sulphuric acid; 4 or 5 turns more; run through cold water, and wring out; repeat in the iron and prussiate tubs as before dyeing; give the fustic moderately warm in a clean liquor; turn 30 minutes; lift, and raise in the same liquor with 5 lbs. alum and 6 oz. extract of indigo; winch in this till you get the required shade.

FAST CHROME GREEN.—For 56 lbs. 10¾ lbs. chrome, 5 lbs. acetate of lead. Blue on the blue vat, *cotton;* wash in 2 waters, and give a warm sour then dissolve, and put the lead and chrome into separate tubs; enter in the lead tub first; wring out; then through the chrome; continue from the one to the other till dark enough.

Vats for Various Colours.—WOAD VAT.—250 gallons water, 170° Fahrenheit, put in 150 lbs. best English woad, well chopped; 9 lbs. best indigo, well ground; 2½ lbs. madder; 2½ lbs. bran. Rake altogether well up, and the vat ought to assume a green appearance; in 12 or 14 hours, dip a piece of cloth, or a little wool, into the vat; if it dye green, it will turn blue by exposure to the air; rake up, and if it holds the head well up, put in 1 quart of quicklime, and rake again; in 3 hours after, rake again, and if it looks of a greenish yellow, put in 1½ quart more of lime; in 3 or 4 hours after, rake again; if the vat looks yellower, use another quart of lime; in an hour after this, if it smells slightly of lime, it has enough; if it smells strongly of lime, it has too much, which may be counteracted by using 1½ or 2 lbs. of madder, or by heating the vat; when the liquor is hard, it is of an orange colour, which may be seen by blowing; when it is soft, it appears faint yellow, and throws up a scum. In serving or heating the vat, it should

be raked occasionally, taking care not to disturb the sediment, but merely to bring the liquor to an equal degree of heat; then put in 3 lbs. indigo, and 1½ lb. madder; allow it to settle for 12 hours; then, if it looks of a greenish colour, and does not smell of lime, use 1 quart of lime. In all cases, if the vat smells slightly of lime, it is a proof that it has enough; if it smells very strongly of lime, give 1½ lb. of potash, and 2 lbs. madder; then, if it smells of lime instead of woad, cool by taking off the covering, and a considerable quantity of the lime will evaporate; heat up again, and put in 30 or 35 lbs. of woad; when hot, rake well up; look at the vat in 6 or 8 hours, if the upper part of the liquor looks yellow, rake up, and if it does not darken, use 2 quarts of lime: when you rake up, stir the bottom at all times, except when heating up; 3 hours is long enough for a woad vat to settle. In dyeing silk or cotton on this vat, it is safest to work it cold, or at most lukewarm.

Ash Vat, *Woollen.* — 400 gallons water, heat to 170° Fahrenheit, 5 lbs. ground indigo, 10 lbs. American potash, 3 lbs. madder, 4 lbs. bran. Apply a slow fire, and it will come to fermentation in 14 or 16 hours; then add 1 or 2 lbs. madder. In renovating this vat, use more potash in proportion to your indigo, than in setting a new vat.

Blue Vat, *Cotton.* — 140 gallons water, 16 lbs. copperas, 8 lbs. ground indigo, 16 lbs. quicklime. Rake up occasionally for 5 or 6 hours, till all the copperas be dissolved; if the vat be of a greenish yellow colour, consider it in good order; if it assumes a dark green colour, it shows a deficiency of lime; if yellowish, it is short of copperas; after raking, allow 12 hours to settle before working; renovate with copperas and lime, according to the state of the vat.

Purple Vat.—Boil 1 cwt. of the best logwood in 30 gallons of water for 3 or 4 hours, when it will be reduced to 26 gallons; decant the clear liquor into a wood or stone vessel; let it stand till quite cold, and add 56 lbs. purple vat spirits, 7° Twaddle. In renovating this vat, it is made up with raw muriatic acid till the glass stands as high as when set.

Crimson Vat.—Boil 1 cwt. limawood; decant it in the same manner as the last, and add 56 lbs. crimson vat spirits; renovate with killed spirits, 7° Twaddle.

Lavender Vat.—50 lbs. Boil 14 lbs. logwood in 10 or 12 gallons water; decant the clear into a 60-gallon tub containing 40 gallons of water; when it is quite cold, add 45 lbs. lavender spirits; rake up occasionally for 3 or 4 hours; next day it will be fit for working, and the glass will stand at 6° Twaddle. This will dye lilac; add neutralized paste for lavender. Renovate with raw muriatic acid till the glass stands at 6°.

Rose Pink Vat.—Boil 1½ lb. of limawood in 3 gallons water; decant the clear into a tub containing 20 gallons water, and add 5 quarts double muriate of tin; the hydrometer will stand at 7°; renovate with double muriate of tin.

Silk Spirits. Nitro-sulphate of Iron.—2 galls. of 30 lbs. double aquafortis, 24 lbs. copperas. Put the aquafortis into a leaden or stoneware pot place it near a fire, and add the copperas at 3 or 4 times; if without the convenience of a fire, put in a quart of hot water with the first of the copperas.

Nitrate of Iron.—2 galls. aquafortis, 5½ lbs. old iron. Put this into a 6-gallon pot; add the iron by degrees; and keep it warm, like the last.

Scarlet.—3 lbs. muriatic acid, 3 lbs. pure double nitric acid; add 2 oz. sal ammoniac, and feed with 1½ lb. granulated tin.

Purple Vat Spirits. — 4 galls. (54 lbs.) marine acid, 1½ gall. (20 lbs. nitric acid. Kill with 3½ lbs. granulated tin; ¾ oz. to the pound.

Crimson Vat Spirits. — 3 galls. muriatic acid, 2 galls. nitric acid, 2 oz. sal ammoniac, fed with 3½ lbs. tin.

Lavender.—30 lbs. muriatic acid, 15 lbs. double nitric acid. Kill with 3 lbs. granulated tin; nearly 1 oz. to the pound.

Muriate of Tin.—Give any quantity of muriatic acid as much tin as it can consume; you will know when it has enough, by seeing tin lying undissolved at the bottom of the pot.

Double Muriate of Tin.—It requires twice as much tin as the last; it may be made by heating common muriate of tin in a stoneware pot, placed in a hot sand-bath, and giving as much tin as it can consume.

Indigo, Extract of. — 1 lb. best ground indigo, 6 lbs. double vitriol. Mix together; let stand 48 hours in a stone pot; then put the vessel into a warm bath till properly dissolved; take 6 gallons water, 170° Fahrenheit; add the indigo slowly, filter through woollen cloth, covered with brown paper, into a wooden vessel; what remains on the paper put away, as it is only earth; then add your liquor, 4 lbs. common salts, 1 lb. pearl-ash. Let it stand till it ceases fermenting, then filter again through brown paper, and what remains on the paper is pure extract of indigo; there should be 12 lbs. of it.

Ammonia Paste. — 1 quart strong ammonia, 1 ditto water, 2 lbs. ground cochineal. Stir them all well together in a stone pot; tie up the mouth of it tightly, and set it in some warm place, such as the flue of a stove, for two days, and it will be fit for use.

Woollen Spirits. Royal Blue. —2 quarts of muriatic acid, 1 ditto nitric acid, no tin. Before using, let it stand until the gas goes off.

Scarlet Spirit.—Put any quantity of nitre, and the same of clear water, into a stoneware pot; the water first; then add 1 lb. muriatic acid to every 5 lbs. of the above, and give 2 oz. of tin to the pound of spirits, adding it very slowly for one or two days, because in giving the tin too fast the spirits get fired, which precipitates the nitre, and they are lost.

Crimson Spirits are the same as scarlet spirits, but have more tin dissolved in them; give as much as they will take, till they turn of a bluish colour.

Lac Scarlet Spirit.—3 galls. muriatic acid, 2 galls. water, feed with 6 lbs. tin, 1 gall. nitric acid.

Purple Spirits.—1 gall. muriatic acid, feed with 2 lbs. granulated tin, or an ounce to every gill.

Cotton Spirits, Red.—For 50 lbs. 40 lbs. muriatic acid, 10 lbs. nitric acid, carefully and slowly killed with 9½ lbs of tin, or 3 oz. of tin to the pound.

Purple. — 2 quarts muriatic acid, feed with 1½ lb. tin, or 1½ oz. to the gill.

Black Liquor.—300 lbs. copperas dissolved with 175 galls. hot water, then add 57 galls. acetate of lime liquor at at 16° Tw., or 32 lbs. copperas, 5 quarts pyroligneous at 7° Tw., 10 galls. acetate of lime liquor at 24° Tw. Used as a mordant; gives black with madder at 6° Tw.; very diluted gives various shades of violet, and with red liquor gives chocolates.

Red Mordant.—20 lbs. powdered alum is dissolved in 9 galls. water heated to 140°; mix with this 20 lbs sugar of lead, and add 2 lbs. soda crystals; should be frequently stirred for days. Used in the above proportions for calico.

Red Mordant, *for Madder Pink.* —8 lbs. alum, 9 quarts water, 6 lbs. sugar of lead. For lighter pink, use 10 galls. water, 37 lbs. alum, 15 lbs. sugar of lead, 2½ lbs. pulverized chalk, 5 lbs. chloride of sodium or common chalk.

Ageing Liquor.—20 lbs. caustic soda at 60° Tw., 20 lbs. white arsenic in powder. Boil until all the arsenic is dissolved. Make a solution of 3 lbs. of chlorate of potash in 4 galls. of water; add the first liquor until it stands at 28° Tw.

Pink Mordant, *Alkaline.* — 10 galls. caustic potash add slowly 35 lbs. sulphate of alumina; thicken with British gum, and fix with chloride of zinc or sal ammoniac.

Verdigris.—2 quarts water at 160° Fahr., 2 lbs. white sugar of lead, 2 lbs. sulphate of copper. Used in calico printing, and in the black dye for silk.

Cheap Filter.—Take a common flower-pot as large as possible, plug the

hole with a piece of sponge, then put a layer of powdered charcoal about an inch thick, the same of silver sand, and a layer of small stones and coarse gravel about 2 in. thick. A good filter may be made by placing in a tank of impure water a vessel so arranged that a sponge which it contains shall lap over its edge and dip into the water of the tank. The sponge gradually sucks up and purifies the water in the reservoir, and allows it to drop into the smaller vessel or receiver, from which it may be drawn off by a tube. By placing a few lumps of charcoal in the bottom of the receiver, filtration of the most perfect kind is effected.

Glue Melting.—Break the glue into small pieces and soak from twelve to twenty-four hours in cold water, put the glue in the glue-pot, fill the outer vessel with water, and apply heat. For ordinary purposes it should run freely, and be of the consistency of thin treacle. The hotter glue is, the more force it will exert in keeping the two parts glued together; in all large and long joints, the glue should be applied immediately after boiling. Glue loses much of its strength by being often melted; that glue, therefore, which is newly made, is much preferable to that which has been used. When done with add some of the boiling water from the outer vessel to the glue, so as to make it too thin for use. Put it away till wanted again, and by the time the water in the outer vessel is boiled, the glue in the inner is ready melted and the proper thickness for use. Powdered chalk, brick-dust, or saw-dust added to glue, will make it hold with more than ordinary firmness.

Liquid Glue. — 1. Soft water, 1 quart; best pale glue, 2 lbs.; dissolve in a covered vessel by the heat of a water bath; after cooling, add with caution 7 oz. of nitric acid; when cold, bottle off. 2. White glue, 16 oz.; dry white-lead, 4 oz.; soft water, 2 pints; alcohol, 4 oz.; stir together, and bottle while hot. 3. 3 parts glue broken into small pieces should be covered with 8 parts of water, and left to stand for some hours; one-half of hydrochloric acid and three-fourths of sulphate of zinc must then be added, and the whole exposed to a temperature of from 81° to 89° C. during ten or twelve hours. Allow the compound to settle.

Elastic Glue.—Dissolve glue by the aid of a water bath, evaporate till thick fluid is obtained, add an equal weight of glycerine, continue the evaporation with stirring until the remaining water is driven off; run it out on a marble slab to cool. This composition might be advantageously applied to the manufacture of printers' rollers, and similar articles.

Glue for Gutta-percha.—2 parts common black pitch, and 1 part gutta-percha, melted in a ladle and well stirred together, then run into moulds.

Portable, or Mouth Glue.—Fine pale glue, 1 lb.; dissolve over a water bath in sufficient water, add brown sugar, ¼ lb.; continue the heat till amalgamation is effected; pour on a slab of slate or marble, and when cold cut into squares. Used by moistening with the tongue.

Glue to resist Heat or Moisture.—Mix a handful of quicklime in 4 oz. of linseed oil; boil them to a good thickness, then spread it on tin plates in the shade, and it will become very hard, but may be easily dissolved over the fire as glue. A glue which will resist the action of water is made by boiling 1 lb. of common glue in 2 quarts of skimmed milk.

Marine Glue.—1. Dissolve by heat 1 part of pure india-rubber in naphtha; when melted add 2 parts shellac; melt until mixed. Pour while hot on metal plates to cool; when required to use, melt and apply with a brush. 2. Caoutchouc, 20 grains; chloroform, 2 fluid oz.; dissolve and add 4 drachms of powdered mastic; let it macerate for a week; must be kept cool and well corked.

Rice Glue.—Mix rice flour intimately with cold water, and gently simmer it over the fire, when it readily forms a delicate and durable glue.

Bookbinders' Paste.—Place half a quartern of flour in a saucepan, put as much cold water on it as will cover it,

and stir it well up, so as to break all the lumps while in a state of dough. Then pour on about 2 quarts of cold water and 1 oz. of powdered alum. Stir well and boil till it becomes thick.

Putty.—Mix a quantity of whiting into a very stiff paste with linseed oil, rubbing and beating it well before using. For particular purposes, as for fanlights, iron-framed greenhouses, and other places where the lap or hold is very narrow, a little white-lead may be added to advantage. Coloured putty has a mixture of red ochre, lampblack, or other colour with the whiting.

SOFT PUTTY.—10 lbs. of whiting and 1 lb. of white-lead, mix with the necessary quantity of boiled linseed oil, adding to it ½ a gill of the best salad oil. The last prevents the white-lead from hardening and preserves the putty in a state sufficiently soft to adhere at all times, and not by getting hard and cracking off, suffering the wet to enter, as is often the case with ordinary hard putty.

TO SOFTEN PUTTY.—1 lb. of American pearlash, 3 lbs. of quick stone lime; slack the lime in water, then add the pearlash, and make the whole about the consistence of paint. Apply it to both sides of the glass and let it remain for twelve hours, when the putty will be so softened that the glass may be taken out of the frame with the greatest facility.

Sealing-wax, *Red.*—Take 1 lb. of yellow resin, 5½ oz. of gum lac, 5½ oz. of Venice turpentine, and 1 oz. of vermilion. Melt the lac in a copper pan suspended over a clear fire, add the resin, pour the turpentine slowly in, and soon afterwards add the vermilion, stirring the mixture all the time. Form either into round sticks by rolling it out on a smooth stone slab by means of a wooden board, or into oval sticks by casting it into stone moulds made in two pieces.

Black sealing-wax is made by substituting either lampblack or ivory-black in the above receipt.

Gold Sealing-wax. — To common colourless sealing-wax, made of shellac 5 parts, add turpentine 1 part, and when melted and beginning to cool, gold-coloured spangles of mica, Dutch leaf, or gold.

Potting, BODIES.—English porcelain and earthenware are made from the following bodies, which are prepared by soaking the clays in a large vessel of water, and when of the consistence of slip passing them through the finest silk lawn into another vessel in which proper gauges are fixed, so that the other materials may be afterwards added in a slop state. Clay slip should weigh 13½ lbs.; Cornish clay, 13½ lbs.; Cornish stone, 16½ lbs.; and flint, 16¼ lbs. a gallon. The passing through the lawn is repeated as often as is needful, so that the mixture may be deprived of impurities. Care must be taken that the bones used for china bodies are not decayed, and for the other materials used in making porcelain, great care is necessary to see that they are of the purest kinds. These bodies fire at a higher temperature than that usually observed, and are placed and fixed in the furnace with ground flint. For the coloured bodies the marls used should be selected of the finest quality, argillaceous marl being the best; and very fine lawn will be required if it is intended that the body should be clean and free from metallic spots. Clay in which the silicious ingredients are in proportion of three to one are the best for the use of porcelain; those in which argil is in excess are the best for coarser earthenware, because less acted upon by alkalies. The colours in clays produced by vegetables or bituminous particles are destroyed by heat in an open fire, and are by no means prejudicial; but those which arise from metallic particles are obstinate, and should be avoided as much as possible. Clays which contain argil and silex only are very refractory, but calcareous earths in the proportion of 10 to 12 per cent. will render any clay fusible. The clays for porcelain should be those which contain the most sand, and are of the greatest fineness; also such as do not retain water with too much tenacity, which is the case when argil is not com-

bined with fixed air, therefore all clays ought to be exposed to the action of the atmosphere for a long time previous to using. Calcareous earth in its common form is limestone or spar, magnesia, &c., which in their pure state are not so easily dissolved as when combined with fixed air. Argillaceous clay or alumina clay forms the basis of common alum; is called argil, and is never found pure; the finest part is extracted from alum, and is not fusible in the strongest heat required for china or earthenware. Argil in its usual state of dryness is capable of absorbing two and a half times its weight of water. Silicious earths found in a stony state abound in flint; the purest are found in crystals and quartz of a pure white; fixed alkalies, vegetables, or minerals are their true solvents. It should be understood that flint and bones, in all instances, are to undergo the process of calcination previous to using.

FIRING.—Articles formed of one of the bodies are first moderately burnt in earthen pots, to receive a certain degree of compactness, and to be ready for glazing. The *glaze* consists of an easily melted mixture of some species of earths, which, when fused together, produce a crystalline or vitreous mass, and which after cooling is very finely ground and suspended in a sufficient quantity of water. Into this fluid the rough ware is dipped, by which the glazing matter is deposited uniformly on every part of its surface. After drying, each article is thoroughly baked or fired in the violent heat of the porcelain furnace. It is usual to decorate porcelain by paintings, for which purpose *enamels* or pastes, coloured by metallic oxides, are used, so easy of fusion as to run in a heat less intense than that in which the glazing of the ware melts.

PORCELAIN BODY.—1. 360 parts of bones; 230, Cornish clay; 50, Cornish stone; 20, flint; 20, blue or brown clay; 10, *body frit* (p. 45); $\frac{1}{2}$, blue calx. 2. 400 parts, bones; 360, Cornish clay; 250, Cornish stone; 20, flint; $\frac{3}{4}$, blue calx.

IRONSTONE BODY.—1. 300 parts Cornish stone; 250, Cornish clay; 200, blue or brown clay; 100, flint; 1, blue calx. 2. 175 parts, Cornish stone; 150, Cornish clay; 90, blue or brown clay; 35, flint; 5, body frit; $\frac{1}{2}$, blue calx. These bodies are very ductile, and fire at the temperature of the common biscuit oven; each piece of ware should be perfectly dry when placed in the seggars, because they are made a great deal thicker than any other kind. Setters also should be used at the bottom of each piece, and ground flint applied, but not sand, for the placing or seating; the body, when burnt, is quite vitrified, and the pieces of ware strong and heavy, ringing remarkably shrill.

PRINTED EARTHENWARE BODY, *Superior.*—3 parts, blue clay; 1, black or brown clay; 2, Cornish clay; $1\frac{1}{4}$, flint; $\frac{1}{4}$, Cornish stone.

—— *Common.*—2 parts, blue clay; 2, brown or black clay; 1, Cornish clay; $1\frac{1}{4}$, flint.

CREAM-COLOURED BODY, *Superior.*—$1\frac{1}{2}$ part, blue clay; $1\frac{1}{2}$, brown clay; 1, black clay; 1, Cornish clay; 1, flint; $\frac{1}{4}$, Cornish stone.

—— *Common.*—$1\frac{1}{2}$ part, blue clay; $1\frac{1}{2}$, brown clay; $1\frac{1}{2}$, black clay; 1, flint.

LILAC PORCELAIN BODY.—200 parts, bones; 115, Cornish clay; 25, blue clay; 20, flint; 15, chalk; 10, Cornish stone; $1\frac{1}{4}$, blue calx.

DRAB BODY.—24 parts, argillaceous marl; 48, Cornish stone; 24, blue clay; 10, bones; 1, calcined nickel.

COMMON BROWN, or COTTAGE BODY.—20 parts, red or brown clay; 8, Cornish clay; 4, blue clay; 2, flint.

FAWN, or DRAB BODY.—40 parts, marl; 4, Cornish clay; 1, flint.

CALCEDONY BODY.—32 parts, yellow clay; 10, Cornish clay; 4, flint.

BROWN BODY.—50 parts, red clay; $7\frac{1}{2}$, common clay; 1, manganese; 1, flint.

JASPER BODY.—10 parts, chalk; 10, blue clay; 5, bones; 2, flint; $1\frac{1}{4}$ blue calx. All the materials should be ground together, as much depends on the different articles being well united, which adds greatly to its fineness in

colour and lustre. It fires at the temperature of earthenware ovens.

SUPERIOR WHITE BODY.—50 parts, chalk; 50, blue clay; 25, bones; 10 flint. This body is of the same consistency, and requires the same temperature as the jasper body. It is perfectly adapted also for the purpose of figures in bas-relief, and other ornamental work.

STONE BODY.—480 parts, Cornish stone; 250, blue and brown clay; 240 Cornish clay; 10, glass; 1, blue calx. This body will be sufficiently vitrified at the temperature of the earthenware biscuit oven, and is adapted for the purpose of manufacturing jugs, mugs, and so on; it is requisite to place rings on each piece of ware, in order to keep them from being crooked when burnt in the oven; in all other respects to be treated as earthenware bodies.

STONE MORTAR BODY.—480 parts, Cornish stone; 250, blue and brown clay; 240, Cornish clay; 10, glass; principally used for making stone mortars, and when burnt is of a yellowish white, absolutely vitrified, exceedingly strong, very durable, and produces a clear bell sound.

BLACK EGYPTIAN BODY.—235 parts, blue clay; 225, calcined ochre; 45, manganese; 15, Cornish clay; the materials must be accurately examined on account of the manganese, which ought to be free from lime or other calcareous earth; the pieces of ware when manufactured are very apt to crack, because of the sudden transition from heat to cold, provided above a certain proportion of lime is contained in the manganese. This kind of earthenware requires only once burning, after which it is scoured with fine sand, and then a small quantity of oil rubbed over it.

RING BODY.—150 parts, blue clay; 100, Cornish stone; 100, bones; 52, plaster. Used for making rings and setters, for placing porcelain and ironstone; the porcelain clay which gets dirty or injured by working may be used for the same purpose, in the proportion of two of the former to one of the latter.

SAUCER MOULD BODY.—10 parts, flint; 4, blue clay; 2, Cornish clay; 1, black clay. Prepared for the sole purpose of making moulds, principally those of saucers; moulds made in this way are preferable, and considerably more durable than those which are made of plaster; the contraction of this clay in burning is inconsiderable.

FAWN POROUS BODY.—40 parts, argillaceous clays; 4, blue clay; 2, flint. This body makes porous wine and butter coolers, and water bottles, on the principle of absorption and evaporation. The articles are generally ornamented with various coloured clays, according to the five following recipes; they should be kept in the wet clay state, at the time of being painted, otherwise the different colours laid upon them will not sufficiently adhere, but are liable to chip and peel off when burnt. A moderate degree of heat must be applied, as too great a temperature will cause the body to be too dense, and prevent absorption; it will therefore be necessary to fire such articles in the easy parts of an earthenware biscuit oven.

Silicious and Argillaceous Clays.—These clays are for the purpose of painting porous coolers and bottles in the Mosaic style, and are equally applicable to the ornamenting of china and earthenware; the mixtures must be well ground, for their fineness has a great tendency to equalize the contraction and expansion of bodies in firing.

WHITE CLAY.—4 parts, blue clay; 2, Cornish clay; 2, flint; 1, Cornish stone.

BLUE CLAY.—30 parts, *white clay;* 1, blue calx.

BLACK CLAY.—4 parts, black Egyptian clay; 1, *white clay;* 1, *blue clay.*

ORANGE CLAY.—4 parts, yellow clay; 2, Cornish clay; 1, flint; ¼, Cornish stone.

GREEN CLAY.—12 parts, *white clay;* 1, nickel; ¼, *blue clay.*

Glazes.—PORCELAIN GLAZE.—40 parts, Cornish stone; 45, red-lead; 38, borax; 32½, flint; 22½, flint glass; 13, crystal of soda; 5, oxide of tin; 1, enamel blue. The particles are made small and well mixed together, then calcined

in the coolest part of the glazing oven, in seggars thickly lined with flint; care must be observed that the frit is not too highly calcined, or brought into a high state of vitrification; if so, it will render it difficult to grind, and injure its good qualities in dipping. The frit likewise if too finely ground will cause the glaze to be uneven on the surface of the ware; if any inconvenience of this nature arises, by adding a solution of potash in hot water, that defect will be instantly obviated.

IRONSTONE GLAZE.—36 parts, Cornish stone; 30, borax; 20, flint; 15, red-lead; 6, crystallized soda; 5, oxide of tin; $\frac{1}{8}$, blue calx. With the above frit is to be added 15 parts, white-lead; 10, Cornish stone; 10, flint; when ground together, the composition is ready for use; should the glaze prove too thin for dipping, add a small quantity of muriatic acid.

BODY FRIT.—60 parts, Cornish stone; 40, flint; 30, crystallized soda; 8, oxide of tin; 10, borax. This frit is used in small quantities, in china and ironstone bodies.

FRIT FOR GLAZES.—1. 40 parts, Cornish stone; 36, flint glass; 20, red-lead; 20, flint; 15, potash; 10, white-lead; 3, oxide of tin. This frit is intended to be used in glazes, in lieu of those which contain a large proportion of borax; therefore, by substituting it when the price of that article is high, will, of course, be advantageous, and the texture of the glaze will still be good and admissible.

2. 36 parts, Cornish stone; 30, red-lead; 20, flint; 20, borax; 15, crystal of soda; 5, oxide of tin. These two frits may be calcined in the easy part of the glazing oven, in seggars lined with flint; particular care should be observed that they are clean chipped, and free from pieces of seggars, or any dirty substance.

EARTHENWARE PRINTED GLAZE, *Superior.*—90 parts, white-lead; 35, Cornish stone; 20, flint glass; 20, flint; 60, frit (for glazes, 2); $\frac{1}{4}$, blue calx.

Common.—85 parts, white-lead; 35, Cornish stone; 22, flint; 15, flint glass; 24 frit (for glazes, 2); $\frac{1}{5}$, blue calx. These glazes, when ground, to be sifted through a fine lawn; the former glaze is of the finest texture, and will require rather a thinner coating when dipped than those of common glazes. Fire in seggars, either washed with common glaze, or a mixture of lime and slip without flint.

COMMON PRINTED GLAZE.—90 parts, white-lead; 45, Cornish stone; 22, flint; 20, flint glass; $\frac{1}{4}$, blue calx. To this, after being properly ground and sifted, add 1 lb. of common salt and $\frac{1}{2}$ lb. of borax, which forms a smear or flow, as it is generally termed, but must not be put into the glaze until the blue stain is perfectly incorporated with it; the ware dipped therein must be placed in seggars washed with glaze.

WHITE EARTHENWARE GLAZE.—35 parts, Cornish stone; 20, borax; 10, crystal of soda; 20, red-lead; $\frac{1}{8}$, blue calx. Calcine and then pulverize coarsely, and grind with 20 lbs. white-lead, 10 lbs. Cornish stone, and 5 lbs. flint.

BLUE AND GREEN EDGE GLAZE.—72 parts, litharge; 36, Cornish stone; 20, flint glass; 17, flint; 12, frit (for glazes, 2); $\frac{1}{5}$, blue calx. The blue and green edged ware when dipped in this glaze should be perfectly dry previous to being placed in the seggars, and the green edge should be seated in the coolest part of the glazing oven.

CREAM-COLOUR GLAZE, *Superior.*—85 parts, white-lead; 40, Cornish stone; 22, flint; 16, flint glass; 8, frit (for glazes, 2).

Common.—75 parts, litharge; 40, Cornish stone; 23, flint; 10, flint glass.

CRYSTAL GLAZE.—105 parts, Cornish stone; 90, borax; 60, flint; 50, red-lead 12, crystal of soda; 10, oxide of tin; $\frac{1}{4}$, blue calx. This glaze produces very superior white earthenware, and, for the purpose of enamelling, the colours, lustres, and burnished gold appear to considerable advantage; it is also adapted for ironstone, and makes superior blue printed earthenware; it has a singularly striking effect on printed brown and mulberry. When used for dipping it must be considerably diluted, and requires but

little shaking from the hand of the operator. It requires the heat of a china glazing oven, but to answer the earthenware oven a small addition of white-lead must be made, according to the temperature of firing. The materials must be mixed and calcined, and the ware fired in lime and slip seggars, well washed.

BROWN COTTAGE GLAZE.—60 parts, litharge; 32, flint; 8, brown slip. This and the two following glazes require using about the same consistency as the cream-colour glaze, and will stand the highest temperature of heat in a common glazing oven.

CALCEDONY GLAZE.—65 parts, litharge; 40, Cornish stone; 20, flint; 6, frit (for glazes, 2).

DRAB GLAZE.—70 parts, litharge; 30, flint; 25, Cornish stone; 10, drab slip.

BLUE GLAZE.—50 parts, flint; 30, borax; 22, red-lead; 10, Cornish stone; 6, crystallized soda; 6, oxide of tin; 3, blue calx. In preparing this glaze follow the same directions as for porcelain glaze.

GREEN GLAZE.—3 parts, blue vitriol, calcined; 1, flint glass; 1, flint. When ground, take 4 quarts of this mixture to 30 quarts of the following mixture, ground:—35 parts, litharge, 20, flint; 10, Cornish stone; 10, frit, for glazes. This glaze is sufficiently fired in the coolest part of the glazing oven. Particular attention should be observed as to the proper wash used for the seggars, for much depends on that simple process. The brightness and lustre of the glaze will be secured by adopting the following wash:—5 parts of the solution of quicklime; 1, of clay slip, free from the least particle of flint, and applied about the thickness of common glaze.

YELLOW GLAZE.—95 parts, white-lead; 35, flint glass; 20, flint; 14, oxide of yellow; 10, Cornish stone; 16, frit, for glazes. The oxide of yellow must be very finely ground, and the other materials ground and sifted before the oxide of yellow is added. It would be as well first to mix the yellow and the frit together, then let them be passed through a lawn into a vessel containing the other ingredients; by this means the materials will be better incorporated; use it about the same thickness as cream-coloured glaze, and treat it the same. It will fire almost in any part of the oven, in seggars either washed with glaze or mixture of lime and slip.

ALKALINE GLAZE.—30 parts, borax; 30, flint; 18, Cornish stone; 2, oxide of tin. The materials must be calcined, and particular caution observed in the course of chipping from the seggars, that not the least particle of any colouring matter be mixed with it, for it is very susceptible of being materially injured in its colour; when ground, a small quantity of muriatic or nitrous acid should be added, and at the same time quickly stirred about, and the motion continued for some time, in order to prevent it setting at the bottom of the vessel; in all other respects treated the same as common glazes, except with regard to dipping, in which case it must be used very thin.

Colours under Glaze, with the exception of the green, should be mixed together and calcined in a reverberatory furnace or glazing oven, in seggar hillers, or dishes lined with flint; then spread on the mixture about an inch in thickness, observing that the hiller or dish have a sufficient access of air allowed, to prevent the metals from reviving again in their metallic state: the green ingredients only require grinding.

NAPLES YELLOW UNDER GLAZE.—12 parts, white-lead; 2, diaphoretic antimony; 1, crude sal ammoniac; $\frac{1}{2}$, alum. Mix intimately, calcine in a crucible, over a slow fire, for the space of three hours, stirring it nearly the whole of the time, when the mass will be found of a beautiful yellow or gold colour.

LINING BROWN UNDER GLAZE.—7 parts, glass of antimony; 3, raw litharge; $2\frac{1}{2}$, manganese; 1, nitre; 1, blue calx.

PAINTING BROWN UNDER GLAZE.—5 parts, glass of antimony; 5, raw litharge; 2, manganese; $\frac{1}{2}$, blue calx.

ORANGE UNDER GLAZE.—6 parts, raw litharge; 4, crude antimony; 2, crocus-martis; 1, oxide of tin.

YELLOW UNDER GLAZE.—4 parts, raw

litharge; 3, crude antimony; $1\frac{1}{2}$, oxide of tin.

GREEN UNDER GLAZE. — 12 parts, oxide of yellow; 4, white enamel; 2, frit (for glazes prepared without the oxide of tin); $1\frac{1}{4}$, blue calx.

PRINTED BROWN UNDER GLAZE.—5 parts, raw litharge; 5, crude antimony; $2\frac{1}{2}$, manganese; 1, blue calx.

PRINTED BLACK UNDER GLAZE.—3 parts, red-lead; $1\frac{1}{4}$, antimony; $\frac{3}{4}$, manganese. After these ingredients have been calcined, add the following, and calcine again: 2 parts, blue calx; $\frac{1}{4}$, oxide of tin. This black under glaze, in the last stage of preparation, must be calcined in the highest heat of a biscuit oven, and *crystal glaze* is the most suitable to it. The ware must be fired in an easy part of the glazing oven; the brown calcined in the usual way, and dipped in the common printed glaze.

PRINTED MULBERRY UNDER GLAZE. —4 parts, manganese; 2, blue calx; 1, nitre; $\frac{1}{2}$, borax. Calcine this colour in the usual way, either in a dish or seggar hiller, and after the mixture is spread on the dish or hiller, a small quantity of pounded nitre should be scattered thinly over, and when calcined, add 2 parts of flint glass; 1, flint; then grind all the ingredients up together for use.

GREEN FOR EDGING UNDER GLAZE.— 3 parts, oxide of copper; 3, flint glass; 2, flint; 2, oxide of tin; 1, enamel blue. Grind these ingredients together, after which add 8 quarts of *earthenware printed glaze*, and 4 quarts of *cream-colour glaze*, mix well together, and sift them through a fine lawn. Lay this green on the ware after it is dipped, and fire it in the coolest part of the glazing oven.

BLUE PRINTED FLUX. — 1. 2 parts, flint; 1 frit, for glazes; $\frac{1}{2}$, flint glass. 2. 5 parts, flint; $1\frac{1}{2}$, borax; $\frac{1}{2}$, nitre. 3. 3 parts, flint glass; $2\frac{1}{2}$, flint; 1, nitre; 1, borax.

PAINTING AND EDGING BLUE. — 2 parts, blue calx; 3, frit, for glazes; $1\frac{1}{2}$, flint glass; 1, flint; $\frac{1}{2}$, white-lead. The frit should be prepared without the oxide of tin, when mixed with the blue calx, for that metal and arsenic are both prejudicial to its colour.

STRONG PRINTING BLUE. — 2 parts, blue calx; 3, *blue printed flux.*

WEAK PRINTING BLUE.—1 part, blue calx; 4, *blue printed flux* (2).

Printing Oil for Pottery.—1. 1 quart linseed oil, 1 pint rape oil, 2 oz. balsam capivi, 1 oz. pitch, $\frac{1}{2}$ oz. amber oil, $\frac{1}{2}$ oz. white-lead. 2. 1 quart linseed oil, $\frac{1}{4}$ pint rape oil, $\frac{1}{2}$ pint common tar, 1 oz. balsam sulphur, 1 oz. balsam capivi. The linseed oil should be boiled for some time alone, then add the rape oil and the balsam capivi, allow the boiling to be continued until it begins to approach the proper consistency, and add the remaining ingredients. The mixture should be allowed to cool a short time, after which the whole mass may be boiled slowly until it has assumed the proper thickness; the vessel must be generally covered during the process, and the sulphur previously to being mixed with the oil should be perfectly pulverized, as by that means it is less liable to curdle the oil.

Stains for Pottery. — In preparing these stains the ingredients must be ground remarkably fine, and then so perfectly dried as not to leave the least humidity, after which they must be ground again with oil prepared for the purpose, composed of 2 parts of balsam of sulphur, 1 part of amber oil, and as much turpentine as will render them of a proper consistency; they may then be used with ease for painting various devices on biscuit ware.

BLUE STAIN.—5 parts, blue calx; 2, *frit, for glazes,* without oxide of tin; 1, flint glass; 1, enamel blue.

YELLOW STAIN.—3 parts, *yellow under glaze;* 1, frit, for glazes; $\frac{1}{4}$, chromate of iron.

GREEN STAIN.—3 parts, blue stain; 1, yellow stain; $\frac{1}{2}$, enamel blue green.

Gold Flux.—11 parts, borax; $5\frac{1}{2}$, litharge; 1, oxide of silver. In these enamel fluxes the materials are to be made very fine, particularly the flint, and mixed well together, so that the particles may more easily concrete when in a state of fusion; then calcined in an

air furnace or an earthenware glazing oven, when the whole mass, by means of the proper temperature of fire, will be changed into a brittle resplendent and transparent glass.

Enamel Flux.—1. 8 parts, red-lead; 6, flint glass; 3, borax; 3, flint. 2. 7 parts, red-lead; 4, borax; 2¼, flint. 3. 4 parts, borax; 3, red-lead; 3, flint glass; 2, flint. 4. 3 parts, red-lead; 1, flint glass; 1, flint.

Smalts.—32 parts, sand; 32, potash; 10, borax; 1, blue calx. These smalts, the materials of which are calcined in the usual manner, when finely pulverized will produce a fine rich-looking blue powder.

Enamels for Porcelain Painting.—The enamels, after being finely ground, should be thoroughly dried; then mixed up with turpentine, and used like other colours with a pencil; after which fused again, and vitrified by fire. Spirits of tar may be substituted instead of turpentine in all enamels, with the exception of blue and colours prepared from chrome. With regard to the burning, the lustres will bear the highest temperature of an enamelling heat; the rose colour, cornelian red, and pomona green require a less degree of heat, and are generally placed in the middle of the kiln or muffle, as well as burnish gold; other colours are not so susceptible of being destroyed by heat, and will fire in any part of the kiln or muffle. The even surface of the various coloured grounds on china is produced by first laying the space wanted with linseed oil, previously boiled with a little red-lead and a small portion of turpentine; the enamel colour is then ground fine, and dusted on the oiled part with cotton wool, or laid on with a large camel-hair pencil. The component parts of the different colours are as accurately stated as possible, but the preparation principally depends on observation, therefore experiments will be necessary that a proper judgment may be formed.

White Enamels.—These require the materials to be made very fine and calcined in air furnace, the heat at first to be generated very gradually; and when the whole mass is in a state of fusion increase the fire quickly, and there will soon be produced a fine white enamel; in the time of fusion it will be requisite to keep stirring the whole together with an iron spatula or rod.

Venetian White Enamel.—3½ parts, flint; 3, borax calcined; 1, Cornish stone; ½, oxide of tin.

Common White Enamel.—8 parts, flint glass; 2, red-lead; ½, nitre; ½, arsenic.

Blue Enamels.—For these the materials must be calcined in an air furnace or glazing oven, and caution should be observed that they are not too finely ground at the mill, in order to prevent them from crazing or chipping after being burnt on the pieces of ware. 1. 16 parts, flint glass; 5, red-lead; 2, white enamel; 2, blue calx; 1, common salt; 1, potash. 2. 16 parts, flint glass; 5, red-lead; 2, nitre; 2, potash; 2½, blue calx.

Black Enamels.—Copper black is a very fine colour, the obtaining of which altogether depends upon a proper temperature of heat being applied, for nothing is more fickle and uncertain; if in the least degree overfired the colour is destroyed, and becomes of a dirty green. The other blacks are called umber blacks, and will stand any degree of heat which is required in an enamelling kiln or muffle. The umber to be highly calcined in a biscuit oven, but particular caution should be observed that it is the real Turkey umber, and not the English, which is of an inferior quality. The two first enamel blacks to be calcined in the usual way; the materials of the two latter only want grinding.

Enamel Painting Black.—4 parts, borax; 2, umber calcined; 2½, red-lead; 2, enamel blue; 1, flint; 1, blue calx. A superior black enamel is composed by uniting with 8 parts of this composition, 1 enamel; 1 enamel purple.

Enamel Printed Black.—1 part umber calcined; 1¼, borax calcined; ½, blue calx.

Copper Black Enamel.—1 part, copper calcined; 3, *enamel flux* (1).

RED ENAMEL.—1 part, green copperas calcined 3, *enamel flux* (3). The greatest difficulty in preparing red is the calcination of the copperas; calcine the copperas in a vessel exposed to the heat of an open fire, by which means it will dissipate all its volatile contents, and leave a residue of oxide of iron in powder; when it attains an orange or light red, the calcination is sufficiently accomplished; the residue is then washed repeatedly with boiling water, until the water becomes insipid and free from vitriolic acid.

BROWN ENAMEL, *Dark.*—1 part, copperas calcined brown; 2, *enamel flux* (4); $\frac{3}{4}$, *enamel flux* (1). Brown enamel only requires grinding before it is fit for use; the copperas for the purpose of making dark brown will require calcining in the most intense heat of a biscuit oven; the colour of it varies according to the temperature it undergoes, first white, then orange, red, and lastly brown.

Light.—1 part, umber calcined; 1, yellow under glaze; $\frac{1}{2}$, copperas calcined red; $\frac{1}{4}$, white enamel; $5\frac{1}{2}$, *enamel flux* (2); 3, *enamel flux* (3).

BLUE GREEN ENAMEL.—42 parts, red-lead; 15, flint; 12, borax; $2\frac{3}{4}$, blue vitriol calcined. To these materials, after being calcined in an air furnace or glazing oven, must be added 12 parts of *white enamel*, then grind them all together.

GRASS GREEN ENAMEL. — $3\frac{2}{3}$ parts, blue green frit; 1, enamel yellow.

YELLOW GREEN ENAMEL.—$2\frac{1}{2}$ parts, blue green; 1, enamel yellow.

YELLOW ENAMEL. — 1 part, Naples yellow; 2, *enamel flux* (1); 1, *enamel flux* (3).

ORANGE ENAMEL. — 1 part, orange under glaze; 2, *enamel flux* (1); 1, *enamel flux* (4).

PURPLE DISTANCE ENAMEL.—2 parts, enamel purple; 3, oxide of manganese; 12, *enamel flux* (3).

CORNELIAN RED ENAMEL. — 1 part, chromate of iron; $3\frac{1}{2}$, *enamel flux* (4). This fine colour is produced from the chromate of iron, or the yellow oxide of chroma, which has a greater affinity for lead than an alkali, consequently the flux prescribed is the only one which is susceptible of yielding its proper colour, as those fluxes which contain a large proportion of borax are very prejudicial, destroying the colour, and with the greatest difficulty forming any affinity at all, therefore should be avoided. The flux used should be highly calcined until it assumes a dark orange-coloured glass. Mix up with spirits of turpentine when dry.

POMONA GREEN ENAMEL. — 1 part, oxide of green chrome; $2\frac{1}{2}$, *enamel flux* (1); $1\frac{1}{2}$, *enamel flux* (4). This green is prepared by simply grinding the ingredients, and produces that dark colour equal to the French green, provided the oxide is genuine; and by adding a proportion more of flux and white enamel, there still will be a rich tint, though weaker and lighter in colour.

Burnish Gold from Brown Gold.—12 parts, brown oxide of gold; 8, quicksilver; 2, oxide of silver; 1, white-lead. Put the whole of these ingredients into an earthenware mortar, and triturate them until the whole is amalgamated; the mercury being the solvent fluid, very readily combines with the rest, to which it communicates more or less of its fusibility, after which grind them very fine with spirits of turpentine.

BURNISH GOLD FROM GREEN GOLD.—12 parts, green gold; $7\frac{1}{2}$, quicksilver; $1\frac{1}{2}$, oxide of silver; $1\frac{1}{2}$, gold flux. Place the gold in an earthenware vessel on an open fire, and when heated red hot, take four times its weight of mercury, and pour it in; the mixture to be stirred with a little iron rod; the gold will be dissolved; it is then thrown into a vessel full of water until it coagulates and becomes manageable; much of the mercury is then pressed through a piece of leather, and the rest dissolved by a quantity of nitrous acid; the acid is afterwards poured off, the gold remaining is repeatedly washed with boiling water as often as needful; it is then dried and mixed up with the other ingredients, and ground with spirits of turpentine for use.

PURPLE ENAMEL.—4 parts, gold in

solution; 1, tin in solution. Procure a vessel to contain 50 parts of water about the temperature of blood-heat, to be well mixed with the solution of gold, and then add the solution of tin by dropping it into the menstruum, at the same time constantly stirring it with a strong feather, which will produce a fine purple-colour liquor; but it will be necessary to add a few drops of the solution of silver, which will much assist to raise the colour and beauty of the purple; to help the precipitation of the gold from its solvent (provided the precipitation does not immediately take place) add a large proportion of boiling water or a small quantity of sal ammoniac, and a precipitate will instantly be procured; the clear liquor must then be decanted off, and the boiling water repeated until it is completely insipid. The residue consists of the oxides of gold, tin, and silver in combination, and is the only substance which has the property of communicating the purple colour to enamel glass; after the precipitate is prepared the flux must be added; the proper quantity will solely depend on the fusibility or softness of the flux, and as the operation in a great measure depends on observation, a few experiments by the operator will be found useful, independent of the accuracy of the receipt. To the purple precipitate may be added from 30 to 45, flux, *enamel flux* (3), according to the strength of colour intended to be made.

ROSE-COLOUR ENAMEL.—3 dwts., gold in solution; 60 leaves, book silver; 2½ lbs., *enamel flux* (1). Procure a vessel to contain 10 parts the quantity of hot water, then mix the water and gold together while the water is at the temperature of 190° F.; add pulverized sal ammoniac rather copiously, at the same time briskly stirring the mixture with a strong feather, until the appearance of a decomposition takes place, which will soon be observable by the gold being precipitated from the menstruum in the form of a fine yellow powder; when that is accomplished, let the vessel stand undisturbed a short time to allow the precipitate to subside, then decant the liquor off, and still add boiling water repeatedly to the precipitate until the water is perfectly insipid; in the next place put it on a plaster bat to dry, after which it must be mixed up with book silver and flux, according to the proportions given above, and well triturated in a mortar; then send it to the mill to be ground, when it will be in a proper state for use. This colour is supposed to be best when of a purple tinge, which may be produced by merely calcining the preparation to the heat of ignition previous to being ground; if the colour be too dark, the mixture does not possess a sufficient quantity of silver; if it is too light, the silver must have been very plentifully added, therefore the operator must add or diminish accordingly. Great caution must be observed with this receipt, as the gold precipitated by the sal ammoniac will unite with it, and then has the property of fulminating; and when gently heated or smartly struck with any hard instrument will immediately detonate; this can only be obviated by a plentiful use of boiling water; a caution which ought to be strictly attended to, as it removes the dangerous quality by depriving the gold of its salt.

GOLD LUSTRE.—Take grain gold and dissolve it in aqua regia, as in the receipt for *solution of gold;* add 5 grains of tin; an effervescence takes place when the solution is completed and in a proper condition to be mixed; take balsam of sulphur 3 parts, spirits of turpentine 2 parts, mix them well together over a slow fire, then gradually drop the solution of gold into the menstruum, and keep stirring until the whole solution be added; provided the mixture should appear too thick, add more turpentine till of a proper consistency. 1 oz. of gold dissolved in the manner described will make upwards of 2 lbs. weight of prepared lustre, and must be used with turpentine, for all other spirits are injurious.

PERSIAN GOLD LUSTRE.—Take any quantity of the precipitate of gold, first mixed with a small portion of fat oil on a flat piece of earthenware, then

place it on a stone previously heated, and when the mixture begins to be in an eliquated state, stir it well with a palette knife, and keep adding more oil by a little at a time, until with the continuance of a gentle heat it assumes the colour of balsam of sulphur, then add, with a less degree of heat, turpentine in small quantities. 1 oz. of the precipitate of gold will make about 1 lb., more or less, of lustre, having more solidity and opacity than the *gold lustre*. The proportions of the fat oil of turpentine to the spirits of turpentine, are 1 part of the former to 3 of the latter.

SILVER or STEEL LUSTRE.—This is prepared by taking platina and dissolving it in aqua regia composed of equal parts of spirits of nitre and marine acid. The solution must be placed in a sand bath, at a moderate temperature; then take 3 parts of the spirits of tar, and 1 part of the solution of platina, mixing the solution with the tar very gradually, for as soon as the combination takes place, an effervescence will arise, the nitrous acid will evaporate and leave the platina in combination with the tar. After the above process has been performed, should the menstruum be found too thin and incapable of using, set it on a sand bath as before for a few hours; the spirit of the tar will evaporate, and by that means a proper consistence will be obtained. It must be used with spirits of tar.

Oxide of Platina. — Dissolve platina as for *silver lustre*. Let the solution fall into a large vessel of water at the temperature of blood-heat; the sal ammoniac must then be added, and the precipitate will immediately descend to the bottom of the vessel in an orange-colour powder; decant off the water, and repeatedly apply to the precipitate boiling water until the water becomes quite insipid; after being gradually dried it is then used for the purpose of producing a silver lustre in the following manner:—First, procure brown earthenware of a full soft glaze, and with a broad camel-hair pencil lay on all over the piece of ware the platina in solution, and fire it at a strong enamel ling heat, by which it will acquire a shining steel-colour lustre; then take the oxide of platina mixed up with water to a thickish consistence, and lay it on the steel lustre, and fire it again in a kiln or muffle, but not to exceed a blood-red heat; it is then called silver lustre, being less resplendent, having more solidity and whiteness, and a very similar appearance to silver. On all white earthenware the platina in solution is perfectly sufficient to produce a silver lustre.

Bronze Gold.—2½ parts, burnish gold; 2, oxide of copper; 1, quicksilver; ¼, gold flux. Having dissolved the copper in aqua fortis, it is again separated from its solvent and falls to the bottom of the vessel by the addition of iron; the precipitate of copper may be increased or diminished at discretion, which makes the bronze richer or poorer in colour according to the proportion of burnish gold contained in the mixture. It is chiefly used for ornamenting the handles and heads of jars, vases, and so on, and occasionally intermixed with burnish gold.

Solution of Gold.—Put 40 dwts. of aqua regia in a small bottle, to which add 5 dwts. of grain gold, the solution will immediately commence, and may be observed by the effervescence which arises at the time; when the solution is complete, the whole of the gold will be dissolved, which will be accomplished in about two hours if the acids be genuine, but when they are not, it will be requisite to apply heat to assist in facilitating the solution.

Solution and Oxide of Silver.—1 part of nitric acid, and 3 parts of boiling water; add one-third of its weight of silver, dilute with five times its quantity of water, then add a portion of common salt, stirring it all the time and immediately a white precipitate will fall to the bottom of the vessel; the liquor must then be decanted off and boiling water repeatedly added, until the water is quite insipid. This precipitate is the pure oxide of silver, and is the same as that used in the prepara-

tion of burnished gold and in staining of glass.

Solution of Tin.—2 parts of nitrous acid, and 1 part of muriatic acid, with an equal part of water; add granulated tin by small pieces at a time, so that one piece be dissolved before the next is added. This aqua regia will dissolve half its weight of tin; the solution when properly obtained is of a reddish brown or amber colour, but when gelatinous the solution is defective.

Oxide of Tin.—Take any given quantity of grain tin, and granulate it by melting the tin in an iron ladle; when in fusion pour it into a vessel full of cold water, by which means the tin will be reduced into small grains or particles adhering to each other; then take a biscuit dish previously lined with flint, spread it slightly over with pounded nitre, take the granulated tin, and lay it on the dish 2 inches in thickness, adding a little more nitre on the top; 1 lb. of nitre will be sufficient to oxidate 5 lbs. of granulated tin; the dish containing the tin and nitre is to be calcined in a reverberatory furnace or glazing oven; particular attention is required in seating it, so that plenty of room remains to admit a free access of air to pass over the metal, otherwise it is impossible to obtain the whole of it in an oxidated state.

Balsam of Sulphur.—Take 2 parts of flour of sulphur, and 4 parts of turpentine; put them in a vessel over a slow fire until the sulphur is completely dissolved; after which add 8 parts of linseed oil, and continue the same degree of heat for about one hour; previous to becoming cold strain it through a piece of cloth.

Regulus of Zaffre.—112 parts, zaffre; 57, potash; 18½, charcoal. The charcoal being pulverized, and all the materials mixed up together, they are put into large-sized crucibles capable of holding from 3 to 4 quarts, and filled quite full, then placed in a strong brick-built reverberatory furnace, commencing with a slow fire, and continued for some time, but as soon as it is heated to a red-heat, it will require a considerably stronger fire before the cohesion between the different particles is sufficiently destroyed. This operation will be complete in about ten hours, the weight of the regulus being from 31 to 33 lbs.; on examining the scoria, if there remains mixed with it small pieces of metal like small shot, or when pounded, if the scoria has a bluish cast, the fire has not been strong enough; there is but little danger to be apprehended from the most intense heat, provided the particles in fusion do not perforate the crucibles. At the bottom of each cake of regulus there will be bismuth slightly adhering, which is easily separated without the application of any great degree of heat, by placing the cakes upon an iron plate or pan, which will soon bring the bismuth into a state of liquefaction, and it can then be separated from the regulus.

To Refine Regulus of Zaffre.—50 parts, regulus of zaffre; 6, potash; 3, sand; pulverize and well mix, then put in crucibles holding about 1½ lb. each, and fire in a reverberatory furnace, commencing with a slow fire and gradually increase the heat for about eight hours; by that time the regulus will have fallen to the bottom of the crucible, and the scoria found at the top will be of a blackish green; it will then be necessary that another course of refining should take place, in order that the regulus may be obtained in a more perfect state of purity.

Blue Calx.—1. 30 parts, refined regulus of zaffre; 1, plaster; ½, borax. 2. 30 parts, refined regulus of cobalt; 1, plaster; ½, borax. These materials to be made very fine, and well mixed; put the mixture in earthenware biscuit cups 1½ in. high, 3 in. in diameter, and 1½ in. thick, filled nearly to the top; set them in a furnace, the fire to be increased until the mixture is in a state of fusion, the same degree of heat must be continued for about six hours afterwards, and then the fire hastily slackened; this operation will occupy from twelve to thirteen hours; at the top of the cups will be found a blue calx separated from the nickel; but as a large proportion of blue will still remain in the nickel when sunk to the bottom of the cups,

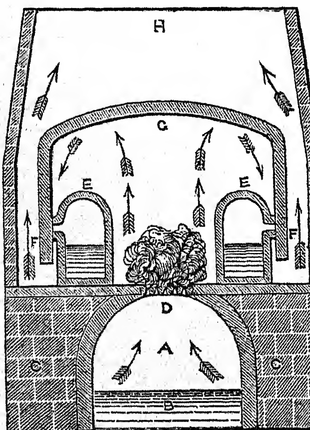
it will be necessary, in order to procure the whole of the blue contained, to pursue precisely the same method over again.

Cobalt Blue, or **Regulus of Cobalt.**—60 parts, cobalt ore; 50, potash; 25, sand; 10, charcoal. Work the same way as for *regulus of zaffre.*

To Refine Regulus of Cobalt.—50 parts, regulus of cobalt; 6, potash. Refine as for *regulus of zaffre*; the operation of refining must be repeated until the scoria is of a bright colour and of a slight bluish hue; then spread the purified metal, finely pulverized, half an inch thick, on flat pieces of earthenware covered with flint; place in a reverberatory furnace, and apply a moderate degree of heat for a few hours.

Glass Making.—The furnace in which glass is made is a large circular building capable of holding about six pots or vessels, in which the glass is melted. Fig. 1 is an ordinary arrangement of this furnace.

Fig. 1.



It is built upon an arch, and the space underneath, included within the arch, is called the cave, as at A. This apartment can be closed by the doors C C, to regulate the draught, as all the air necessary for the support of the fire must enter at these doors. On the upper part of the cave is placed a grate D, to support the fire. The ashes pass through this grate and fall into a tank of water B. Around this grate pillars are constructed, which, being hollow, serve as flues F F. Resting upon these pillars is an iron dome G, and on this is built the principal chimney H. Between these pillars are placed the pots E E, which, from the peculiar construction of the furnace, receive the heat equally on all sides; for, as the flame ascends it strikes the dome, and is reverberated, taking the direction pointed out by the arrows. The pots are constructed in the form of a cylinder, with a hemispherical top, having a small aperture on one side for the admission of the materials, and their removal when formed into glass. When the pots are placed in the furnace, they are so arranged that their openings are on the outside of the fire; they are then built in by a temporary wall, except the orifices, so that no dust or smoke can enter so as to injure the glass. The materials for these various kinds of glass are placed in the pots, and exposed to the heat of the furnace for upwards of forty-eight hours, during one-half of which time the heat is gradually increased, and during the other half gradually decreased, until the *metal*, as the workmen term the glass, is in a fit state for working. During the time the materials are in the pot, the workman takes out a portion, from time to time, on an iron rod, and examines it when cold, to see whether it is free from air bubbles and of good colour. If the materials employed be very impure, there rises to the surface a scum, which is called sandiver or glass gall, and which resembles large flakes of snow.

Flint Glass is employed for making lenses, decanters, drinking glasses, and owes its capability of being thus easily fashioned to the lead contained in it. The following quantities form a very excellent glass:—Fine white sand, 300 parts; red-lead, or litharge, 200; refined pearlashes, 80; nitre, 20; arsenic and manganese, a smaller quantity.

CROWN GLASS is a compound of silica, potash or soda, and lime. It is employed as a window glass, and contains no lead. The proportions for its formation are—Fine white sand, 100 parts; carbonate of lime, 12; carbonate of soda, 50; clippings of crown glass, 100.

BOTTLE or GREEN GLASS is made of the commonest materials, in about the following proportions:—Sand, 100 parts; kelp, or impure soda, 30, wood ashes, 40; potter's clay, 100; cullet, or broken glass, 100.

PLATE GLASS.—Great care is required in the choice of materials, and the management of the process for this glass. The following proportions are used:—Finest white sand, 720 parts; best soda, 450; lime, 80; nitre, 25; cullet, or broken plate glass, 425.

COMMON WINDOW GLASS.—100 parts, sand; 35, chalk; 35, soda-ash, and a considerable quantity of broken glass or cullet.

COLOURS FOR GLASS.—Oxide of gold is employed to impart to glass a beautiful ruby colour. Sub-oxide of copper gives a red colour. Silver, in all states of oxidation, gives a variety of beautiful yellow and orange colours to glass. Antimony, lead, and silver, in combination, are employed to produce the inferior yellow colour. The oxides of iron give to glass various shades of green, yellow, red, and black. Oxide of chromium gives a fine green, and oxide of cobalt a splendid blue. The colour most valued, next to that produced by gold, is the yellow communicated by oxide of uranium, and which has an appearance resembling shot silk. White glass or enamel is made by adding either arsenic or the oxide of tin to the melted *metal*. The various metals employed in colouring glass are also used in the manufacture of artificial gems, and by their means the colour and general appearance are well imitated.

STRASS.—Pure caustic potash, 16 parts; white-lead, 85; boracic acid, 4½; arsenious acid, ⅙; finest white sand, 50. These materials are carefully selected, placed in a Hessian crucible and fused in a porcelain furnace for a day and a night, then cooled very gradually. Used to imitate the diamond. Other precious stones are imitated by adding to the strass the metallic oxides, as in *colours for glass*.

SOLUBLE or WATER GLASS.—Mix well 200 grains of fine sand, and 600 of fine carbonate of potassa; fuse in a crucible capable of holding four times as much. Carbonic acid escapes; the silica and potassa combine and form glass. Pour out the glass, which is commonly termed silicated potassa, on an iron plate. The compound formed in this manner is pure silica soap.

HARD GLASS FOR RECEIVING COLOUR.—Best sand, cleansed by washing, 12 lbs.; pearlashes, or fixed alkaline salt purified with nitre, 7 lbs.; saltpetre, 1 lb.; and borax, ½ lb. The sand being first reduced to powder in a mortar, the other ingredients should be put to it, and the whole well mixed by pounding them together.

Glazing Windows.—*Crown glass* is made in circular disks blown by hand; these disks are about 4 ft. diameter, and the glass averages about $\frac{1}{15}$ in. thick. Owing to the mode of manufacture there is a thick boss in the centre, and the glass is throughout more or less striated or channeled in concentric rings, frequently curved in surface, and thicker at the circumference of the disk. Consequently in cutting rectangular panes out of a disk there is a considerable loss, or at least variety in quality: one disk will yield about 10 sq. ft. of good window glass, and the largest pane that can be cut from an ordinary disk is about 34 × 22 in. The qualities are classified into *seconds*, *thirds*, and *fourths*.

Sheet glass is also blown by hand, but into hollow cylinders about 4 ft. long and 10 in. diameter, which are cut off and cut open longitudinally while hot, and therefore fall into flat sheets. A more perfect window glass can be made by this process, and thicker, and capable of yielding larger panes with less waste. Ordinary sheet glass will cut to a pane of 40 × 30 in., and some to 50 × 36 in. It can be made in thicknesses from $\frac{1}{16}$ in. to ¼ in.

Plate glass is cast on a flat table and rolled into a sheet of given size and thickness by a massive metal roller. In this form, when cool, it is *rough plate.*

Ribbed plate is made by using a roller with grooves on its surface. Rough and ribbed plate are frequently made of commoner and coarser materials than polished plate, being intended for use in factories and warehouses.

Polished plate is rough plate composed of good material and afterwards polished on both sides, which is done by rubbing two plates together with emery and other powders between them. Plate glass can be obtained of almost any thickness from $\frac{1}{8}$ in. up to 1 in. thick, and of any size up to about 12×6 ft.

In the glazing of a window the sizes of the panes, that is to say, the intervals of the sash-bars, should be arranged, if practicable, to suit the sizes of panes of glass which can conveniently be obtained, so as to avoid waste in cutting; this consideration is of more consequence in using crown and sheet glass than with plate glass. The woodwork of the sash should receive its priming coat before glazing, the other coats should be put on afterwards. With crown glass, which is sometimes curved, it is usual to place the panes with the convexity outwards. When the glazier has fitted the pane to the opening with his diamond, the rebate of the sash-bar facing the outside of the window, he spreads a thin layer of putty on the face of the rebate and then presses the glass against it into its place, and holding it there, spreads a layer of putty all round the side of the rebate, covering the edge of the glass nearly as far as the face of the rebate extends on the inner side of the glass, and bevelling off the putty to the outer edge of the rebate. The putty is then sufficient to hold the pane in its place, and hardens in a few days. The glass should not touch the sash-bar in any part, on account of the danger of its being cracked from any unusual pressure; there should be a layer of putty all round the edges. This precaution is especially necessary in glazing windows with iron or stone mullions or bars.

Glass Painting and Staining.—The different compounds for painting glass are glasses of easy fusion, chiefly coloured with metallic oxides ground, and laid on the glass with spirits of turpentine. In the production and modification of glass colours much depends on the different preparations of the metals, on the small proportion of the metallic oxides employed in proportion to the vitreous mass, on the degree of fire and time of its continuance, and on the purity of each ingredient intended for vitreous mixtures; from hence difficulties arise which even a skilful operator cannot always remove, and which often frustrate his intention. Having made choice of the subject to be painted, correctly draw the same on a paper exactly the size intended to be on the glass, then place the different pieces in regular order on the drawing and trace the outlines therefrom on the glass; when the tracing is quite dry the ground colours may be washed in together with the dark and prominent shades, and also the stains required. The stains are laid on in various thicknesses, according to the depth of colour required, and when they are dry the glass is ready to be burned in a muffle or kiln constructed for the purpose. The panes of glass are laid on sheets of iron, or earthenware bats, the size of the glass, previously spread over with dried ground flint, to prevent the surface of the glass from being defaced. After the first burning the stain is washed off with warm water, which will bring to view every part of the subject, in fact, every shade according to the thickness of colour applied; to heighten the colour paint on each side of the glass, and burn it a second time. The glass will require from four to six firings, the exact number of firings depending on the subject, the degree of perfection required, and the manner of execution; but after each burning, the pieces of glass will want less labour, some of the colours and stains being perfect at the first and second burning, and few require the utmost quantity. The proper degree of heat to which the glass must be exposed in the muffle is ascertained by

taking out at different intervals small pieces of glass, arranged for the purpose, on which are laid similar colours to those being fired. After the glass is burned it requires great precaution in cooling, for if suddenly cooled it is apt to fly, consequently all sudden changes of temperature should be avoided.

Red Orange and Yellow Stains.—12 parts, green vitriol calcined; 1, oxide of silver. The vitriol must be calcined to a reddish colour, and repeatedly washed with boiling water until it is completely freed from its acid, which will be known by the water being insipid to the taste, then triturate the silver and vitriol together in a mortar, after which grind them up with spirits of tar for use. Various temperatures in burning produce various coloured stains, the highest a red, a less an orange, and so on to a yellow; but to procure a very deep red, the colour must be laid upon both sides of the glass.

White Enamel for Painting Glass.—3 parts, borax calcined; 2, flint; 1, oxide of tin; 1, Cornish stone. The basis of this enamel, which is in general opaque, may also be employed in assimilating the opaque natural stones. These ingredients must be well mixed up together, and fused in an air furnace in a crucible, the fire at first applied very gradually, and the whole repeatedly stirred with an iron rod. The mixture by this calcination, and by being kept for some time in fusion in an intense heat, acquires its fusibility and opacity.

Purple.—1. 20 parts, prepared purple; 2½, *enamel flux* (2); 1, *white enamel*. 2. 20 parts, prepared purple; 10, blue process; 5½, *enamel flux* (2); 1, *white enamel*.

Rose Colour.—20 parts, prepared rose colour; 1, *white enamel*. The purples and rose colours for glass painting are nearly the same mixtures as those used for porcelain painting, with the addition of a small proportion of flux and white enamel, the latter gives firmness to the colour; in the course of working the rose colour, if a very small quantity of purple be added, the colour will be perceivably benefited.

Red.—1 part, terra de sienna; 3, *enamel flux* (2). The terra de sienna must be calcined over a slow fire until its colour becomes of a dark red, after which washed several times in boiling water and ground with the flux for use.

Transparent Orange.—1 part, oxide of silver; 10, *enamel flux* (2); 10, *enamel flux* (3); 1, *white enamel*.

Yellow.—1 part, *yellow, under glaze*, p. 46; 3, *enamel flux* (2); ½, *white enamel*.

Dark Brown.—1 part, highly calcined copperas; 3½, *enamel flux* (3).

Red Brown.—1 part, *black*; 1, *red*; 1, *enamel flux* (4).

Light Brown.—1 part, easy calcined umber; 3½, *enamel flux* (2).

Green.—1. 5 parts, cornelian red; 1, prepared purple. 2. 2 parts, *blue*; 1, *yellow*.

Blue.—1. 8 parts, flint glass; 3, red-lead; 1, potash; 1, blue calx; ½, common salt. 2. 4 parts, borax; 4½, flint glass; 1, flint; ½, potash; ½, prepared purple; 1, blue calx. In preparing these blues, let the materials be calcined in an air furnace, and the whole mass kept in a state of fusion for some time, a fine blue glass enamel will be produced; the cobalt blue calx should be of the finest quality that possibly can be procured, and free from all impurities.

Black.—1. 1 part, highly calcined umber; 2, calcined borax; 1, red-lead 1, blue calx. 2. 1 part, manganese; 1, black flux. The best Turkey umber should be procured for the first process, and calcined at the most intense heat that can be produced in an air furnace, after which pound and mix up with the other materials; then calcine the whole together in an air furnace, the degree of heat will be sufficient when the whole mass is in fusion.

Black Flux, *for glass staining*.—15 parts, red-lead; 5, borax; 5, flint; 1¼, oxide of blue vitriol.

Indigo Blue.—1 part, precipitate of gold; 4½, *enamel flux* (4); ⅛, *white enamel*. These ingredients are simply ground

together for use. They produce a beautiful colour on glass, of a fine purple hue. This very expensive colour is adapted principally for painting the draperies of figures, and is very susceptible of being injured by a high degree of heat.

Etching and Deadening Colour.—1. 7 parts, red-lead; 2, calcined borax; 2, flint; 1, oxide of tin. 2. 8 parts, red-lead; 6, flint glass; 3, flint; ½, green copperas. The materials of the last two processes must be finely mixed and calcined in an air furnace, each process separately, after which take 2 parts of No. 1 and 3 parts of No. 2, mix them together, and repeat the calcination again in an air furnace; then pound and grind this frit for use, but be particular that it is ground very fine, for much depends on the particles being minutely mixed previous to using. The composition is afterwards laid on the glass with water, and a small quantity of refined sugar dissolved in spring water applied occasionally; the solution of sugar must be of the consistence of thick oil; should too large a quantity of the solution be added, and by that means condensate it too much, add a few drops of acetous acid to the menstruum, it will immediately regain a proper consistence, and not at all injure the colour. When the deadening is laid on the glass, the figures must be engraved or etched with a pointed instrument made of wood, bone, or ivory, suitable to the subject, and afterwards burned in a kiln or muffle appropriated for the purpose. It fires at a less temperature than stained glass, although in some instances it will do in the same kiln.

To Transfer Engravings on Glass.—Metallic colours prepared and mixed with fat oil, are applied to the stamp on the engraved brass or copper. Wipe with the hand in the manner of the printers of coloured plates; take a proof on a sheet of silver paper, which is immediately transferred on the tablet of the glass destined to be painted, being careful to turn the coloured side against the glass; it adheres to it, and so soon as the copy is quite dry, take off the superfluous paper, by washing it with a sponge; there will remain only the colour transferred to the glass, which will be fixed by passing the glass through the ovens.

Annealing Glass.—This consists in putting the glass vessels, as soon as they are formed, and while they are yet hot, into a furnace or an oven, not so hot as to re-melt them, and in which they are suffered to cool gradually. It is found to prevent their breaking easily, particularly on exposure to heat. In large works, annealing is performed by passing the glass through the oven, by means of revolving trays constructed for the purpose.

Cutting Glass.—To cut glass vessels neatly, heat a rod of iron to redness, and having filled the vessel the exact height you wish it to be cut with oil of any kind, proceed very gradually to dip the red-hot iron into the oil, which, heating all along the surface, the glass suddenly chips and cracks right round, when you can lift off the upper portion clean by the surface of the oil. If a tube is required to be cut, notch the tube at the point where it is to be divided with the edge of the file, or of a thin plate of hard steel, or with a diamond; after which press upon the two ends of the tube, as if to enlarge the notch, or what is better, give the tube a slight smart blow. This method is sufficient for the breaking of small tubes. Many persons habitually employ an agate, or a common flint, which they hold in one hand, while with the other they rub the tube over the sharp edge of the stone, taking the precaution of securing the tube by the help of the thumb. For tubes of great diameter, employ a fine iron wire stretched in a bow, or, still better, the glass-cutter's wheel; with either of these, assisted by a mixture of emery and water, you can cut a circular trace round a large tube, and then divide it with ease. When the portion which is to be removed from tube is so small that you cannot easily lay hold of it, cut a notch with a file, and expose the notch to the point of a candle flame; the cut then flies round the tube. A good plan of cutting glass is to make

use of a piece of iron heated to redness, an angle or corner of which is to be applied to the tube at the point where it is to be cut, and then, if the fracture is not at once effected by the action of the hot iron, plunge suddenly into cold water. After having made a notch with a file, or the edge of a flint, you introduce into it a little water, and bring close upon it the point of a wire, previously heated to the melting point. This double application of heat and moisture obliges the notch to fly round the glass. Glaziers use for cutting glass a diamond splinter mounted in a holder.

To Draw on Glass.—Grind lampblack with gum-water and some common salt; draw the design with a pen or hair pencil; or use a *crayon* made for the purpose.

Stencilling on Glass—Writing on Glass.—Stencil plates may be cut out of thin sheets of metal or cardboard, in the same manner as for wall decoration, &c. If varnish colours are employed, lay them on as evenly as possible, through the perforations in the plate, and harden afterwards in a stove or oven. The metallic preparations used in glass staining and painting are also available, but require firing in a muffle, or a china painter's stove. Should the process commonly called embossing be wanted, paint the portions of glass left uncovered by the spaces in the stencil plate with Brunswick black, dip or cover with hydrofluoric acid, wash in clear water and remove the black ground. Every part that was covered will then present a polished even surface, the remainder will have been eaten into by the acid. If the raised parts are to have a frosted appearance, rub them with a flat piece of marble moistened with fine emery and water. For putting patterns or lines on glass with a wheel, there are two methods, one followed by glass cutters, the other by the engravers on glass. The first-mentioned, rough in the pattern, with an iron mill supplied with a trickling stream of sand and water, smooth out the rough marks on a wheel of York or Warrington stone, polish on a wooden wheel of willow or alder moistened with pumice powder, and finish on a cork wheel with putty and rottenstone. The engraver cuts in and roughs the pattern with copper wheels, aided by emery of various degrees of fineness, and olive or sperm oil, and polishes the portions intended with leaden disks and very fine pumice powder and water.

Painting Glass for the Magic Lantern.—Draw on paper the size of the glass the subject you mean to paint. Fasten this at each end of the glass with paste, or cement, to prevent it from slipping. Then reverse the glass so as to have the paper underneath, and with some very black paint, mixed with varnish, draw with a fine camel-hair pencil very lightly the outlines sketched on the paper which are reflected on the glass. It would add to the natural resemblance if the outlines were drawn with a strong tint of each of the natural colours of the object; but in this respect the artist must please his fancy. When the outlines are dry, colour and shade the figures; but observe to temper the colours with strong white varnish.

Pigments for Magic Lantern Slides.—The only pigments available are the transparent and a few of the semi-transparent. The transparent include (beginning with the best for the purpose) Prussian blue, gamboge, carmine, verdigris, madder brown, indigo, crimson lake, and ivory black. The semi-transparent include raw sienna, burnt sienna, cappah brown, and Vandyke brown. No particular method of mixing the colours is requisite. Ordinary oil or water colours will do, but they must be ground extremely fine. The pencils must be small and their points unexceptionable. Camel's-hair is preferable to sable for painting upon glass, its elasticity being less, and the trouble of working out the brush marks, which must always be carefully attended to, not so great. The best vehicle to use for thinning the colours is ordinary megilp, and not a drop more than is necessary for properly working should be added, for if the colours be made too thin they will run into each other and utterly ruin the painting. If water colours are

preferred, the best medium for laying on the first wash of colour is a hot solution of transparent gelatine. When this is dry and cold it admits of shading and finishing without being disturbed, provided the pencil be handled gently and the medium be cold water. The oil paintings require no varnishing, but the transparency of the water colours is much heightened by a thin coat of the purest mastic varnish. In colouring the pictures the quality of the light which is to show them must be borne in mind. If it be the lime light, approximate as nearly as possible to nature; but if it be the light of an oil lamp, remember that its rays are greatly deficient in blue, the yellow proportionately preponderating, and arrange the tints accordingly: for instance, the greens must be much bluer than natural, the yellows must incline to orange, and all shades of violet (the complementary of yellow) wholly eschewed.

Glass Cleaning.—Grease may be dissolved from glass by means of carbonate soda, carbonate potass, or better still, by caustic soda, made thus:—10 parts of carbonate soda are dissolved in 100 parts of water (10 oz. to 100 oz.), and heated to ebullition in a clean untinned iron vessel; 8 parts of good quicklime are meanwhile slaked in a covered basin, and the resulting hydrate of lime added, little by little, to the boiling solution of carbonate, with frequent stirring. This will give a very strong caustic solution, and should be used with care. Keep your hands out of the solution, and dip the glass in by means of the pliers, keeping them moving while in the solution. When the grease is dissolved or loosened, scrub with a brush, well rinse in water, and dry.

Frosting Glass.—Roll up tolerably tightly a slip of tin, about 6 in. or 8 in. long and about 2 in. broad, or use a small flat piece of marble. Dip either of these in Croydon or glass-cutter's sand, moistened with water; rub over the glass, whether flat or round, dipping it frequently in a pail or pan of clear water. This is the method employed for frosting jugs, &c. For lamp glasses a wire brush is used, and they are chucked in a lathe. Panes of glass should be laid on a soft bed of baize, or coarse linen. If the frosting is to be very fine, finish with washed emery and water. As a temporary frosting for windows, mix together a strong, hot solution of sulphate of magnesia and a clear solution of gum arabic, apply warm. Or use a strong solution of sulphate of sodium warm, and when cool wash with gum-water to protect the surface from being scratched.

Drilling Glass. — Glass can be drilled with a common drill, but the safest method is to use a brooch drill. No spear-pointed drill can be tempered hard enough not to break. The brooch can either be used as a drill with a bow, or by the hand. It should be selected of such a bore that it will make a hole of the required size, at about one inch from the end. It should be broken off sharp with a pair of pliers, at about an inch and a half, and when the sharp edges are blunted by drilling, a fresh end should be made by breaking off an eighth of an inch, and so on, until the hole is bored. It is always desirable to drill from both sides, as it prevents the glass from breaking; drill lightly, and lubricate with spirits of turpentine and oil of lavender, or a little camphor instead of oil of lavender. Holes may be drilled through plate glass with a flat-ended copper drill and coarse emery and water. The end of the drill will gradually wear round, when it must be re-flattened, or it will not hold the emery. Practically, however, the best means of drilling holes in glass is by using a splinter of a diamond. A brass drill is made to fit the drill-stock, sawn down a little way with a notched knife to allow the splinter to fit tight, and the splinter fixed in the split wire with hot shellac or sealing-wax. The drill is to be used quite dry and with care. If the hole to be drilled is wanted larger than the tool, drill a number of small holes close together to form a circle as large as the hole required, then join the holes with a small file. A splinter of diamond may be bought for 2*s.* (or ·50) big enough to drill a ½ in. hole.

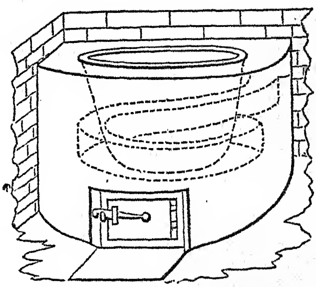
Darkening Glass.—The following, if neatly done, renders the glass obscure yet diaphanous:—Rub up, as for oil colours, a sufficient quantity of sugar of lead with a little boiled linseed oil, and distribute this uniformly over the pane, from the end of a hog-hair tool by a dabbing, jerking motion, until the appearance of ground glass is obtained. It may be ornamented, when perfectly hard, by delineating the pattern with a strong solution of caustic potash, giving it such time to act as experience dictates, and then expeditiously wiping out the portion it is necessary to remove.

Bending Glass Tubes.—If a sudden bend is wanted, heat only a small portion of the tube to a dull red-heat, and bend it with the hand held at the opposite ends. If the bend is to be gradual, heat an inch or two of it in length, previous to bending it. If a gradual bend on the one side, and a sharp one on the other, as in retorts, a little management of the tube in the flame, moving it to the right and left alternately at the same time that it is turned round, will easily form it of that shape. In bending glass, the part which is to be concave is to be the part most heated. An ordinary gas flame is quite sufficient to bend glass by, but that of a spirit lamp is better.

Glass, to Powder.—Make a piece of glass red hot in the fire, and while in this state plunge it into cold water; it will immediately break into powder; this must be sifted and dried; it is then fit for making glass paper, for filtering varnishes, and for other purposes.

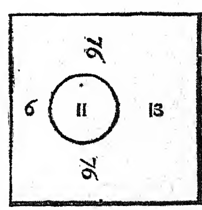
Manufacture of Varnishes.—The building in which varnish is made ought to be quite detached from any other building whatever, and have a door-way in the centre with folding doors made to lift off the hinges. Let the roof of the building slope to the front; fix also in each end wall a frame and door made to lift off the hinges, so that, when necessary, there may be a free draught through the premises. Let three skylights be made and fixed in the roof, not directly over the furnaces, but on one side, so as to throw light on the furnaces. The skylights and flaps must be well secured by lead flushings, to prevent wet getting in, which might be attended with serious consequences. In the left-hand corner, against the back wall, dig out a foundation and fix over a furnace the *set pot*, used for boiling

FIG. 2.



oil, gold size, japan, and Brunswick black. Dig out a foundation facing the front door against the back wall for the boiling furnace, Fig. 2; against the back wall, in the right-hand corner, dig out a foundation for the gum furnace, Figs. 3 and 4; this and all the other fur-

FIG. 3.

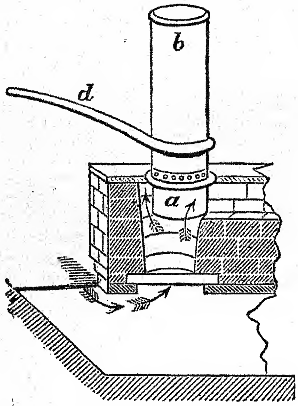


naces require to have slow fires kept in them for a day, in order to dry them slowly, and prevent their cracking. Fig. 3, the top plate, is of cast iron.

Gum pot.—Procure a copper gum pot to fit into the last furnace, Fig. 4. The bottom *a*, Fig, 4, is hammered out of a solid block of copper, and fashioned, all of one piece, exactly like a hat without the brim. The upper part of the pot *b*, is made of sheet copper, of a cylindrical

form, 10 in. diameter at the top, and 2 ft. 2 in. high, about $\frac{3}{8}$ in. thick; the

FIG. 4.



lower part of the cylinder is then riveted to the bottom with copper rivets, the heads of which are inside, and project through the lappings of the copper, flattened on both sides. Previous to riveting on the bottom, a flange of copper, of about $\frac{3}{8}$ in. in thickness, is fixed on to the bottom part, under the large rivets: it is fixed horizontally round the pot. Also previous to riveting on the bottom, put on the iron hoop *d*, $1\frac{1}{2}$ in. in breadth, to which is welded an iron handle, made 1 in. broad by 1 in. thick, gradually increasing to 2 in. in breadth, but decreasing in thickness. The length from pot to handle end 2 ft. 8 in.

Boiling pot.—Procure a copper pot *e* to fit furnace, Fig. 8, the bottom to be beat out of the solid, as the gum pot, and of the following dimensions: Diameter across the bottom outside, 20 in.; height of bottom, 7 in.; the cylindrical or body part of the pot to be 2 ft. 10 in. in depth, and joined to the bottom part with strong copper rivets, made to project through at least three-quarters of an inch, and to be well hammered inside and out; for, as there is no flange, the rivets must be large and strong to support the weight of the pot and its contents while boiling on the furnace plate. It ought to fit the plate neatly, yet so easy as to lift off freely. Seven inches below the mouth of the pot fix on two strong iron handles, one on each side, riveted through each end with two strong rivets; the space for the hands to be 7 in., and $1\frac{1}{2}$ in. in diameter, and to project 4 in. from the pot sides.

Small Tools.—In addition to the furnaces the varnish manufacturer requires two copper ladles, made to hold two quarts each, with turned hardwood handles. Two good ladles for the iron set pot, made of sheet copper or sheet iron, with ash handles. For a pot of 40 gallons, or upwards, the ladle to hold 3 quarts. Two copper stirrers, Fig. 5, made from three-quarter diameter copper rods $3\frac{1}{2}$ ft. long, beat flat at the one end to $1\frac{1}{2}$ in. breadth, 8 in. up the rod; to be finished with ferruled handles 7 in. in length. One large, strong, copper funnel, with lapped seams, for straining boiling varnish or oil; tin or soldered funnels would melt. One copper oil-jack, Fig. 6, which will contain 2 gallons, for pouring in hot or boiling oil, with a large strong pitcher handle, and spout in front. One brass or copper sieve containing 60 meshes to the inch, 9 in. diameter, for straining the first varnish. A brass sieve, 40 meshes to the inch, 9 in. diameter, for straining gold size, turpentine, varnish, boiled oil, &c. A brass sieve, 40 meshes to the inch, and 9 in.

FIG. 5.

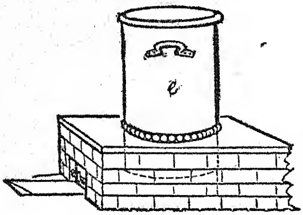
FIG. 6.

FIG. 7.

diameter, for straining japan and Brunswick black. A saddle, Fig. 7, which is a sheet of plate-iron or tin, 12 in. broad, and turned up $1\frac{1}{4}$ in. at each side; it is to lie from the edge of No. 1 pot on

the edge of the funnel, to prevent the spilling of the varnish during the time of taking it out. A tin pouring pot, to hold 3 gallons, made exactly like a garden watering pot, only smaller at the spout, and without any rose; this is never to be used for any purpose except pouring oil of turpentine into the

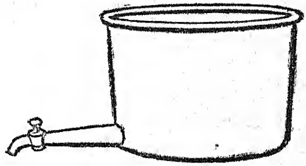
FIG. 8.



varnish. A 3-gallon tin jack, made with a strong handle at back, and a large broad spout in front; used for receiving the washings when poured out from the gum pot. A small broom, termed a swish, made from the waste cuttings of cane tied on a small handle, like a hearth broom, for washing out the gum pot each time it is used; to be always kept clean, and left in oil of turpentine. An iron trevet, made with a circular top 14 in. diameter, with four small cross-bars; the three feet of the trevet 12 in. high; it is used for setting the gum pot upon, with its bottom upwards, for a minute between each running.

BOILING LINSEED OIL.—Procure a copper pan, Fig. 9, made like a common washing copper, set it upon the boiling furnace, Fig. 8, and fill up with linseed oil within 5 inches of the brim. Kindle a fire in the furnace underneath, and manage the fire so that the oil shall gradually but slowly increase in heat for the first two hours; then increase the heat to a gentle simmer, and if there is any scum on the surface, skim it off with a copper ladle, and put the skimmings away. Let the oil boil gently for three hours longer, then introduce, by a little at a time, a quarter of an ounce of the best calcined magnesia for every gallon of oil, occasionally stirring the oil from the bottom.

FIG. 9.



When the magnesia is all in, let the oil boil rather smartly for one hour; it will then be sufficient. Lay a cover over the oil to keep out the dust while the fire is drawn and extinguished by water; then uncover the oil, and leave it till next morning; and then, while it is yet hot, ladle it into the carrying jack, or let it out through the pipe and cock; carry it away, and deposit it in either a tin or leaden cistern, for wood vessels will not hold it; let it remain to settle for at least three months. The magnesia will absorb all the acid and mucilage from the oil, and fall to the bottom of the cistern, leaving the oil clear, transparent, and fit for use. Recollect, when the oil is taken out, not to disturb the bottoms, which are only fit for black paint.

MAKING VARNISH ON A SMALL SCALE.—First procure a gum pot, Fig. 4, or smaller, if required; then a three-footed iron trevet with a circular top, the feet 16 in. in length, and made to stand wider at the bottom than at the top, which is to be made so that the pot will fit easily into it. Place the trevet in a hollow in a yard, garden, or outhouse, where there can be no danger from fire; raise a temporary fire-place round the trevet with loose bricks, after the same manner that plumbers make their furnaces; then make up a good fire with either coke, coal, or wood-charcoal, which is far preferable; let the fire burn to a good strong heat, set on the gum pot with 3 lbs. gum copal; observe, that if the fire surround the gum pot any higher inside than the gum, it is in great danger of taking fire. As soon as

the gum begins to fuse and steam, stir it with the copper stirrer, and keep cutting and stirring the gum to assist its fusion; if it feels lumpy and not fluid, and rises to the middle of the pot, lift it from the fire and set it on the ash-bed, and keep stirring until it goes down (meantime let the fire be kept briskly up); then set on the gum pot again, and keep stirring until the gum appears fluid like oil, which is to be known by lifting up the stirrer so far as to see the blade. Observe, that if the gum does not appear quite fluid as oil, carry it out whenever it rises to the middle of the pot, and stir it down again, keeping up a brisk fire; put on the pot, and keep stirring until the gum rises above the blade of the stirrer. Then the copper pouring jack is charged with boiled oil, and held over the edge of the gum pot; when the gum rises within 5 inches of the pot-mouth, the assistant is to pour in the oil very slowly until towards the last, the maker stirring during the pouring. If the fire at this time is strong and regular, in about eight or ten minutes the gum and oil will concentrate and become quite clear; this is to be tested by taking a piece of glass and dropping a portion of the varnish on it; if it appears clear and transparent, the oil and gum are become concentrated or joined together. It is now to be further boiled until it will string between the finger and thumb; this is known by once every minute dropping a portion on the glass, and taking a little between the forefinger and thumb; pinch it first, then extend wide the finger and thumb; if it is boiled enough, it will stick strong and string out into fine filaments, like birdlime; but when not boiled enough, it is soft, thick, and greasy, without being stringy. It is a safe plan to have ready a thick piece of carpet large enough to cover the mouth of the boiling pot should it catch fire during the pouring. The moment it is boiled enough, carry it from the fire to the ash-bed, where let it remain from fifteen to twenty minutes, or until it is cold enough to be mixed; have at hand a sufficient quantity of oil of turpentine to fill the pouring pot, begin and pour out with a small stream, gradually increasing, and if the varnish rises rapidly in the pot, keep stirring it constantly at the surface with the stirrer to break the bubbles, taking care not to let the stirrer touch the bottom of the pot, for if it should, the oil of turpentine would be in part converted into vapour, and the varnish would run over the pot in a moment; therefore, during the mixing, keep constantly stirring as well as pouring in at the same time. Have also a copper ladle at hand, and if it should so far rise as to be unmanageable, let the assistant take the ladle and cool it down with it, lifting up one ladleful after another, and letting it fall into the pot. As soon as the varnish is mixed put the varnish sieve in the copper funnel placed in the carrying tin, and strain the varnish immediately; empty it into open-mouthed jars, tins, or cisterns; there let it remain to settle, and the longer it remains the better it will become. Recollect, when it is taken out, not to disturb or raise up the bottoms.

Linseed Oil.—The choice of linseed oil is of peculiar consequence to the varnish maker, as upon its quality, to a great extent, depends the beauty and durability of the varnish. Oil expressed from green unripe seed always abounds with watery, acidulous particles. The quality of oil may be determined in the following manner :—Fill a phial with oil, and hold it up to the light; if bad, it will appear opaque, turbid, and thick; its taste is acid and bitter upon the tongue, and it smells rancid and strong: this ought to be rejected. Oil from fine full-grown ripe seed, when viewed in a phial, will appear limpid, pale, and brilliant; it is mellow and sweet to the taste, has very little smell, is specifically lighter than impure oil, and when boiled or clarified dries quickly and firmly, and does not materially change the colour of the varnish when made, but appears limpid and brilliant.

Spirits of Turpentine.—That which is used for mixing varnish ought to be procured and chosen as pure, strong and

free from acid as possible. Some turpentine being drawn from green trees abounds with a pyroligneous acid, which rises and comes over with the spirit in distillation; it is strong and bitter to the taste, and appears milky, particularly towards the bottom, after standing to settle. Therefore, the longer turpentine is kept before it is used, the purer it will be.

Copal Varnishes for Fine Paintings.—Fuse 8 lbs. of very clean pale African gum copal, and when completely fluid, pour in 2 gallons of hot oil; let it boil until it will string very strong; and in about fifteen minutes, or while it is yet very hot, pour in 3 gallons of turpentine. Perhaps, during the mixing, a considerable quantity of the turpentine will escape, but the varnish will be so much the brighter, transparent, and fluid; and will work freer, dry quickly, and be very solid and durable when dry. After the varnish has been strained, if it is found too thick, before it is quite cold heat as much turpentine and mix with it as will bring it to a proper consistence.

Artists' Virgin Copal.—From a select parcel of scraped African gum copal, pick out the fine transparent pieces which appear round and pale like drops of crystal; break these small; dry them in the sun, or by a very gentle fire. Afterwards, when cool, bruise or pound them into a coarse powder; then procure some broken bottles or flint glass, and boil the same in soft water and soda, then bruise it into coarse powder like the gum; boil it a second time, and strain the water from it, washing it with three or four waters, that it may be perfectly clean and free from grease or any impurity; dry it before the fire, or upon a plate; set it in an oven. When it is thoroughly dry, mix 2 lbs. of it with 3 lbs. of the powdered copal; after mixing them well, put them into the gum pot and fuse the gum; keep stirring all the time; the glass will prevent the gum from adhering together, so that a very moderate fire will cause the gum to fuse. When it appears sufficiently run, have ready 3 quarts of clarified oil, very hot, to pour in. Afterwards let it boil until it strings freely between the fingers, begin and mix it rather hotter than if it were body-varnish; pour in 5 quarts of old turpentine, strain it immediately, and pour it into an open jar or large glass bottle; expose it to the air and light, but keep it both from the sun and wet, and from moisture, until it is of a sufficient age for use. This is the finest copal varnish for fine paintings or pictures.

Cabinet Varnish.—Fuse 7 lbs. of fine African gum copal, and pour in half a gallon of clarified oil; in three or four minutes after, if it feels stringy, take it out of doors, and mix with it 3 gallons of turpentine; afterwards strain it, and put it aside for use. This, if properly boiled, will dry in ten minutes, but if too strongly boiled will not mix at all with the turpentine; and *sometimes*, when boiled with the turpentine, will mix, and yet refuse to amalgamate with any other varnish less boiled than itself; therefore it requires a nicety which is only to be learned from practice. This varnish is chiefly intended for the use of japanners, cabinet painters, and coach painters.

Best Body Copal Varnish for Coach Makers.—Fuse 8 lbs. of fine African gum copal; add 2 gallons of clarified oil; boil very slowly for four or five hours, until quite stringy; mix off with 3½ gallons of turpentine; strain off, and pour it into a cistern.

Quick Drying Carriage Varnish.—8 lbs. of fine pale gum anime, 2 gallons of clarified oil, 3½ gallons of turpentine; to be boiled four hours. This, after being strained, is put into the two former pots, and well mixed together; its effect is to cause the whole to dry quicker and firmer, and enable it to take the polish much sooner.

Common Body Varnish for Carriages.—8 lbs. of the best African copal, 3 gallons of clarified oil, 3½ gallons of turpentine; boiled four hours, or until stringy; mixed and strained, will produce about 5½ gallons. 8 lbs. of the best gum anime, 2 gallons of clarified oil, 3½ gallons of turpentine; boiled as

usual; mixed and strained hot, and put into the former pot of African gum varnish. Put two pots of this anime varnish to one of copal; it will dry quicker and harder than the best body copal, and will polish very soon, but not wear either so well or so long.

QUICK DRYING BODY COPAL VARNISH.—8 lbs. of the best African copal, 2 gallons of clarified oil, ¼ lb. of dried sugar of lead, 3½ gallons of turpentine; boiled till stringy, and mixed and strained; 8 lbs. of fine gum anime, 2 gallons of clarified oil, ¼ lb. of white copperas, 3½ gallons of turpentine; boiled as before; to be mixed, and strained while hot, into the other pot. These two pots mixed together will dry in six hours in winter, and in four in summer; it is very useful for varnishing old work on dark colours.

BEST PALE CARRIAGE VARNISH.—8 lbs. of 2nd sorted African copal, 2½ gallons of clarified oil; boil till very stringy. ¼ lb. of dried copperas, ¼ lb. of litharge, 5½ gallons of turpentine; strained. 8 lbs. of 2nd sorted gum anime, 2½ gallons of clarified oil, ¼ lb. of dried sugar of lead, ¼ lb. of litharge, 5½ gallons of turpentine; mix with the first while hot. This varnish will dry hard, if well boiled, in four hours in summer, and six in winter. As its name denotes, this is intended for the varnishing of the wheels, springs, and carriage parts of coaches, chaises, and so on; also it is that description of varnish which is generally sold to and used by house painters and decorators, as from its drying quality and strong gloss it suits their general purposes well.

SECOND CARRIAGE VARNISH.—8 lbs. of 2nd sorted gum anime, 2¾ gallons of fine clarified oil, 5¼ gallons of turpentine, ¼ lb. of litharge, ¼ lb. of dried sugar of lead, ¼ lb. of dried copperas; boiled and mixed as before. When three runs are poured into the boiling pot, the regular proportion of driers put in, and well boiled, this varnish will dry hard and firm in four hours in winter, and in two in summer: it is principally intended for varnishing dark carriage-work or black japan, and is also used by house painters for dark work.

WAINSCOT VARNISH.—8 lbs. of 2nd sorted gum anime, 3 gallons of clarified oil, ¼ lb. of litharge, ¼ lb. of dried copperas, ¼ lb. of dried sugar of lead, 5½ gallons of turpentine; to be all well boiled until it strings very strong, and then mixed and strained. Where large quantities are required, it will always be found best to boil off the three runs in the boiling pot. This varnish is principally intended for house painters, grainers, builders, and japanners: it will dry in two hours in summer, and in four in winter.

Mahogany Varnish is either made in the same proportions, with a little darker gum; otherwise it is wainscot varnish, with a small portion of gold size.

Japanners' Gold Size. — To make 40 gallons of gold size, put 10 gallons of oil into the iron set pot, Fig. 2, make a good fire under it, and boil for two hours; then introduce 7 lbs. of dry red-lead, 7 lbs. of litharge, and 3 lbs. of copperas, by sprinkling in a little at a time; let the oil keep boiling all the time, not in too great a heat. During the time of putting in the driers, keep stirring them from the bottom of the pot, and have the large iron ladle ready to cool it down, if it should appear to rise too high; have also at hand an empty pot—the copper boiling pot will do—into which immediately ladle part of the boiling oil, if it cannot otherwise be kept in the pot, while the assistant is damping the fire with wet sifted ashes, of which there always ought to be a wheelbarrowful at hand, in case of an accident. When the oil has boiled about three hours, and the driers are all in, fuse in the gum pot 10 lbs. of gum anime; and during the time of fusing, heat 2 gallons of raw linseed oil in the copper pouring jack, by placing it on the plate of the gum furnace. After the oil has been poured to the gum, and as soon as it appears boiled clear, take the gum pot from the fire; let it cool for a few minutes, then pour it into the oil in the set pot. Wash out the gum pot, and proceed with another run in

the same way. When both runs of gum are in the set pot, there are altogether 14 gallons of oil, 20 lbs. of gum, and 17 lbs. of driers; increase and keep up a regular fire in the front of the furnace, that it may be drawn out in a moment, if it should be necessary. The gold size will soon throw up a frothy head on the surface, which must be kept down by constantly plying with the ladle when it is likely to rise within four inches of the pot-edge. In about five hours from the beginning of the oil boiling, it will become stringy; but the boiling must continue until it hangs to the ladle, appears quite stringy, yet drops in lumps. When tried upon the glass, if it feels sticky and strings strongly, then it is boiled enough. Draw out the fire, sprinkle it with plenty of water; leave not a spark of fire in the varnish house—not even a lighted pipe of tobacco. While the maker is cooling down the pot, let the assistant have ready at the door 30 gallons of turpentine, fill the pouring pot ready, and have all the doors open. Endeavour to cool it as fast as possible, as it will require at the least one hour and a quarter after the fire has been put out before it will be ready to mix. When the mixing commences, continue the pouring without intermission, until all the froth at the surface disappears, never stirring it until the turpentine is all in. If pouring in the turpentine has commenced while it was too hot, there will be a great loss of turpentine by evaporation; but that will not injure the quality of the gold size. Place the carrying tin close to the side of the pot, lay on the tin saddle, and strain off as quickly as possible. When all the gold size is out, pour into the set pot about 3 gallons of turpentine washings, and with the swish, wash down the pot as quickly as possible; and if the pot is still so hot as to evaporate the turpentine, ladle it out into the washings again, and pour in about 3 gallons of raw linseed oil; and with a palette knife scrape it all round, washing and cleaning it down with a rag until it is quite cleansed all round, then ladle out the oil, and wipe it completely clean and dry. The gold size ought to dry in from fifteen to twenty-five minutes, and in fourteen days it is ready for use. Experienced makers can make gold size that will dry in five minutes, but that requires great practice.

Varnish, Coach Makers' Black.—Gum amber 16 oz.; melt in ½ pint of boiling hot linseed oil; add 3 oz. of asphaltum, and 3 resin; mix thoroughly over a fire, and add when cooling 1 pint of oil of turpentine slightly warm.

Asphalte Varnish.—Boil coal tar until it shows a disposition to harden on cooling; this can be ascertained by rubbing a little on a piece of metal. Then add about 20 per cent. of lump asphalte, stirring it with the boiling coal tar until all the lumps are melted, when it can be allowed to cool and kept for use. This makes a very bright varnish for sheet metals, and is cheap and durable.

Varnish for Ironwork.—Dissolve, in about 2 lbs. of tar oil, ½ lb. of asphaltum, and a like quantity of pounded resin, mix hot in an iron kettle, care being taken to prevent any contact with the flame. When cold the varnish is ready for use. This varnish is for out-door wood and iron work.

Varnish for Common Work.—This varnish is intended for protecting surfaces against atmospheric exposure. It has been used for coating wood and iron work with great advantage. Take 3 lbs. of resin and powder it, place it in a tin can, and add 2½ pints of spirits of turpentine, well shake, and let it stand, occasionally shaking it for a day or two. Then add of boiled oil 5 quarts, well shake altogether, and allow it to stand in a warm room till clear. The clear portion is decanted and used, or reduced with spirits of turpentine until of the proper consistency.

Varnish for Iron Patterns.—A good varnish for iron is made as follows:—Take oil of turpentine and drop into it, drop by drop, strong commercial oil of vitriol; the acid will cause a dark syrupy precipitate in the oil of turpentine; keep adding drops of vitriol until the precipitate ceases taking place,

then pour out the liquid and wash the syrupy mass with water, and it is ready for use. Heat the iron to be varnished to a gentle heat, apply the syrupy product, and allow it to dry.

Black Japan is made after the manner of the gold size. Put 6 gallons of raw linseed oil into the set pot; boil it with a very slow fire. Have a 10-gallon cast-iron pot, with two handles or ears; this pot will fit into the plate of the boiling furnace, into which put 10 lbs. of Egyptian asphaltum, and keep under it a good regular fire all the time of fusion. During the time the asphaltum is fusing, have 2 gallons of oil getting hot to mix it with as soon as it is sufficiently melted. After it is oiled, leave it on the fire about ten minutes; then pour it into the set pot. Carry it out of doors, and with a handful of hay or straw clear it out, and afterwards wash it out with turpentine washings, and dry it with a rag. Proceed and finish three more separate runs like the first, until there are four runs in the set pot, that is, 40 lbs. of asphaltum and 14 gallons of raw linseed oil; then introduce exactly the same driers as for the gold size, and in the same manner. Keep a regular, but moderate fire, so that the boiling continues at a moderate heat for four hours from the last run being poured in the set pot; then draw, and put out the fire for that day. Next morning, as soon as it can be brought to a boil, try it upon a bit of glass; if it but strings strongly, it will not do; it must be boiled so strong, that when a piece is pinched from off the glass, after it has been left to cool, it will roll into a hard pill between the finger and thumb. When it forms hard, and scarcely sticks to the fingers, it is then boiled enough. Put out the fire, as directed before. Leave it one hour and a half before mixing. When cold enough, mix it with 30 gallons, at least, of turpentine, and strain it. If it is too thick when cold, heat and introduce as much turpentine as will bring it to a proper consistency. The japan will dry in 6 hours in summer, and 8 in winter. It is principally intended for and used by coach makers, japanners, or painters, and should be kept at least six months before it is used.

Another Black Japan is made by putting into the set pot 48 lbs. of Naples asphaltum; as soon as it is melted, pour in 10 gallons of raw linseed oil. Keep a moderate fire, and fuse 8 lbs. of dark gum anime in the gum pot; mix it with 2 gallons of oil, and pour it into the set pot. Afterwards fuse 10 lbs. of dark or sea amber in the iron pot. When it appears completely fused, pour in 2 gallons of hot oil, and pour it into the set pot; continue the boiling for three hours longer, and during that time introduce the same quantity of driers as before directed; draw out the fire, and let it remain until morning; then boil it until it rolls hard; leave it to cool, and afterwards mix with turpentine. This japan will appear in colour like the other; but when applied on work, it will dry more hard, compact and glossy, and will not rub down or polish so soon as the other, which is occasioned by the toughness and durability of the amber.

Pale Amber Varnish.—Fuse 6 lbs. of fine-picked, very pale, transparent amber in the gum pot, and pour in 2 gallons of hot clarified oil. Boil it until it strings very strong. Mix with 4 gallons of turpentine. This will be as fine as body copal, will work free, and flow well upon any work it is applied to; it becomes very hard, is durable, and is excellent to mix in copal varnishes, to give them a hard and durable quality. Amber varnish will always require a long time before it is ready for polishing.

Brunswick Black. *Best.*—In an iron pot, over a slow fire, boil 45 lbs. of foreign asphaltum for at least 6 hours, and during the same time boil in another iron pot 6 gallons of oil which has been previously boiled; during the boiling of the 6 gallons introduce 6 lbs. of litharge gradually, and boil until it feels stringy between the fingers; then ladle it into the pot containing the boiling asphaltum. Let both boil until, upon trial, it will roll into hard pills; then cool, and mix with 25 gallons of turpentine, or until it is of a proper consistence.

Common.—Put 28 lbs. of common black pitch, and 28 lbs. of common asphaltum made from gas tar, into an iron pot, boil both for 8 or 10 hours, which will evaporate the gas and moisture; let it stand all night, and early next morning, as soon as it boils, put in 8 gallons of boiled oil; then introduce gradually 10 lbs. of red-lead and 10 lbs. of litharge, and boil for 3 hours, or until it will roll very hard. When ready for mixing, introduce 20 gallons of turpentine, until of a proper consistence. This is intended for engineers, founders, or ironmongers; it will dry in half an hour, or less, if properly boiled.

Ironwork Black.—Put 48 lbs. of foreign asphaltum into an iron pot, and boil for 4 hours; during the first 2 hours introduce 7 lbs. of red-lead, 7 lbs. of litharge, 3 lbs. of dried copperas, and 10 gallons of boiled oil; add one 8-lb. run of dark gum, with 2 gallons of hot oil. After pouring the oil and gum continue the boiling 2 hours, or until it will roll into hard pills, like japan. When cool, thin it off with 30 gallons of turpentine, or until it is of a proper consistence.

Varnish for Prints, Engravings, or Maps.—1. A piece of plate glass is heated, and, while yet warm, a little wax rubbed over it; water is then poured over the plate, and the moistened picture laid thereon and pressed closely down by means of a piece of filtering paper. When dry, the picture is removed, and will be found to possess a surface of great brilliancy, which is not injured by the process of mounting. 2. Boil Chio turpentine till brittle, powder, and dissolve in oil of turpentine. 3. Canada balsam and clear white resin, of each 6 oz., oil of turpentine 1 quart; dissolve. 4. Digest gum sandarach, 20 parts; gum mastic, 8; camphor, 1; with alcohol, 48. The map or engraving must previously receive one or two coats of gelatine.

To Varnish Paper or Cardwork.—1. Boil clear parchment cuttings in water in a clean glazed pipkin till they produce a very clear size, strain it and keep it for use. Give any work two coats of the above size, passing quickly over the work not to disturb the colours; varnish with a paper varnish. 2. Dissolve 1 oz. of the best isinglass in about a pint of water, by simmering it over the fire; strain it through fine muslin, and keep it for use. Try the size on a piece of paper moderately warm; if it glistens, it is too thick, add more water; if it soaks into the paper, it is too thin, add or diminish the isinglass till it merely dulls the surface; then give the paper two or three coats, letting it dry between each, being careful (particularly in the first coat) to bear very lightly on the brush, which should be a flat tin camel-hair. The size should flow freely from the brush, otherwise the paper, if a drawing, may be damaged. Then take the best mastic varnish, and with it give at least three coats.

Varnish for Coloured Drawings.—Canada balsam, 1 oz.; spirits of turpentine, 2 oz. Mix them together. Before this composition is applied, the drawing or print should be sized with a solution of isinglass in water, and when dry apply the varnish with a camel-hair brush.

Varnish for Paintings and Pictures.—1. Honey, 1 pint; the whites of 24 fresh eggs; 1 oz. of isinglass, 20 grs. of hydrate of potassium, ½ oz. common salt; mix together over a gentle heat of 80° or 90° Fahr.; be careful not to let the mixture remain long enough to coagulate the albumen of the eggs; stir the mixture thoroughly, then bottle. Take one tablespoonful of the varnish and add to it half a tablespoonful of good oil of turpentine, then spread on the picture as soon as mixed. 2. Digest at a slow heat gum sandarach, 2 parts; gum mastic, 4; balsam capivi, 2; white turpentine, 3; with spirits of turpentine, 4; and alcohol 50-56 parts. 3. Boil 5 parts bitter apple, freed from the seeds and cut, with rain-water 50 parts, down to one-half. Strain and dissolve in the liquor gum arabic, 8 parts; rock candy, 4; and add 1 of alcohol. Let it stand for some days, and filter. 4. Pure linseed oil, to which a small quantity of sugar of lead, ground fine, has been added. 5. Take equal quantities of linseed oil and oil of turpentine, thicken by exposure to

the sun and air until it becomes resinous and half evaporated, then add a portion of melted beeswax. Varnishing pictures should always be performed in fair weather, and out of any current of cold or damp air.

PHOTOGRAPHERS' NEGATIVE VARNISH.—Gum juniper, 2 drachms 8 grains; gum frankincense, 1 drachm 10 grains; alcohol, 4 oz. Filter through paper and use the clear solution.

TRANSFER VARNISH, *for Diaphanie, Engravings, &c.*—1. Pale Canada balsam and rectified oil of turpentine equal parts. 2. Mastic in tears and sandarach, each 4 oz.; rectified spirit, 1½ pint; dissolve, and add pale Canada balsam ½ pint. Melt the balsam with a gentle heat, mix with the other ingredients and agitate violently. No. 1 is also termed *Crystal Varnish.*

GOLD VARNISH.—Digest shellac, 16 parts; gum sandarach and mastic, of each 3; crocus, 1; gum gamboge, 2; all bruised, with alcohol, 144. Or, digest seed-lac, sandarach, mastic, of each [illegible] parts; gamboge, 2; dragon's blood 4; white turpentine, 6; turmeric [illegible] bruised, with alcohol, 120.

VARNISH FOR GILT ARTICLES.—Gum-lac, 125 parts; gamboge, 125; dragon's blood, 125; annatto, 125; saffron, 32. Dissolve each resin in 1000 parts by measure, of absolute alcohol; two separate mixtures must be made with the dragon's blood and annatto, in 1000 parts of such alcohol; and a proper proportion of each should be added with the gamboge to the varnish, according to the shade of colour required.

BLACK LEATHER VARNISH.—1. Durable leather varnish is composed of boiled linseed oil, in which a drier, such as litharge, has been boiled. It is coloured with lampblack. This varnish is used for making enamelled leather. 2. Digest shellac, 12 parts; white turpentine, 5; gum sandarach, 2; lampblack, 1; with spirits of turpentine, 4; alcohol, 96.

WHITE VARNISH.—1. Tender copal, 7½ oz.; camphor, 1 oz.; alcohol of 95 per cent., 1 quart. Dissolve, then add mastic, 2 oz.; Venice turpentine, 1 oz. Dissolve and strain. Very white, drying, and capable of being polished when hard. Used for toys. 2. Sandarach, 8 oz.; mastic, 2 oz.; Canada balsam, 4 oz.; alcohol, 1 quart. Rectified spirits of wine, 1 quart; gum sandarach, 10 oz., gum mastic, 2 oz.; gum anime, ½ oz. Dissolve in a clean can, with gentle heat. Agitate well when the gums are dissolved; strain through a lawn sieve.

TABLE VARNISH.—1. Oil of turpentine, 1 lb.; beeswax, 2 oz.; colophony, 1 drachm. 2. Dammar resin, 1 lb.; spirits of turpentine, 2 lbs.; camphor, [illegible] grains. Digest the mixture for t[illegible] four hours. The decanted portion is fit for immediate use.

TO VARNISH FURNITURE.—First make the work quite clean; then fill up all knots or blemishes with cement of the same colour; see that the brush is clean, and free from loose hairs; then dip the brush in the varnish, stroke it along the wire raised across the top of the varnish can, and give the work a thin and regular coat; soon after that another, and another, always taking care not to pass the brush twice in the same place; let it stand to dry in a moderately warm place, that the varnish may not chill. When the work has had about six or seven coats, let it get quite hard (which prove by pressing the knuckles on it; if it leaves a mark, it is not hard enough); then with the first three fingers of the hand rub the varnish till it chafes, and proceed over that part of the work intended to be polished, in order to take out all the streaks or partial lumps made by the brush; then give it another coat, and let it stand a day or two to harden.

VARNISHES FOR FURNITURE.—1. Shellac, 1½ lb.; naphtha, 1 gallon; dissolve, and it is ready without filtering. 2. Shellac, 12 oz.; copal, 3 oz. (or an equivalent of varnish); dissolve in 1 gallon of naphtha. 3. Shellac, 1½ lb.; seed-lac and sandarach, each 4 oz.; mastic, 2 oz.; rectified spirit, 1 gallon; dissolve. 4. Shellac, 2 lbs.; benzoin, 4 oz.; spirit, 1 gallon. 5. Shellac, 10 oz.; seed-lac, sandarach, and copal varnish, of each 6 oz.; benzoin, 3 oz.; naphtha,

1 gallon. To darken, benzoin and dragon's blood are used, turmeric and other colouring matters are also added; and to make it lighter it is necessary to use bleached lac, though some endeavour to give this effect by adding oxalic acid to the ingredients; it, like gum arabic, is insoluble in good spirit or naphtha. For all ordinary purposes the first form is best and least troublesome, while its appearance is equal to any other.

CHEAP OAK VARNISH.—Clear pale resin, 3½ lbs.; oil of turpentine, 1 gallon; dissolve. It may be coloured darker by adding a little fine lampblack.

MAHOGANY VARNISH.—Put in a bottle 2 oz. gum sandarach, 1 oz. shellac, ½ oz. gum bengamin, 1 oz. Venice turpentine, and a pint of spirits of wine. Colour red, with dragon's blood, or yellow with saffron. Stand in a warm spot till gum dissolves, when strain for use.

WHITE FURNITURE VARNISH.—White wax, 6 oz.; oil of turpentine, 1 pint; dissolve by a gentle heat. Or white wax, 6 parts; petroleum, 48; applied to the work while warm, allowed to cool, then polished by rubbing with a coarse cloth.

DARK VARNISH FOR LIGHT WOODWORK.—Pound up and digest shellac, 16 parts; gum sandarach, 32; gum mastic, 8; gum elemi, 8; dragon's blood, 4; annatto, 1, with white turpentine, 16; and alcohol, 256. Dilute with alcohol if required.

VARNISH FOR VIOLINS. — Coarsely-powdered copal and glass, each 4 oz.; alcohol, 64 o. p. 1 pint; camphor, ½ oz.; heat the mixture with frequent stirring in a water bath, so that the bubbles may be counted as they rise, until solution is complete, and when cold decant the clear portion. When oil varnish is used it is made as for *Artists' Virgin Copal.*

VARNISH FOR WOOD WHICH RESISTS BOILING WATER.—Linseed oil, 1½ lb.; amber, 1 lb.; litharge pulverized, 5 oz.; white-lead pulverized, 5 oz.; minium, 5 oz. Boil the linseed oil in an untinned copper vessel, and suspend in it the litharge and the minium in a small bag, which must not touch the bottom of the vessel. Continue the ebullition until the oil has acquired a deep brown colour; then take out the bag and put in a clove of garlick; this is to be repeated 7 or 8 times, the ebullition being always continued. Before the amber is added to the oil, it is to be mixed with 2 oz. of linseed oil, and melted over a fire that is well kept up. When the mass is fluid, it is to be poured into the linseed oil this mixture is to be boiled and stirred continually for 2 or 3 minutes; afterwards filter the mixture, and preserve it in bottles tightly corked. When this varnish is used, the wood must be previously well polished, and covered with a thin coat of soot and spirits of turpentine. When this coat is dry, some of the varnish may be applied, which should be distributed equally on every part with a small fine sponge. This operation is to be repeated 4 times, being always careful that each coat be well dried first. After the last coat of varnish, the wood must be dried in an oven, and afterwards polished.

WAINSCOT VARNISH.—Gum anime, 8 lbs.; clarified linseed oil, 3 gallons; litharge, ¼ lb.; acetate of lead, ½ lb.; sulphate of copper, ¼ lb. These materials must be carefully but thoroughly boiled together until the mixture becomes quite stringy, and then 5½ gallons of heated turpentine stirred in. It can be easily deepened in colour by the addition of a little gold size.

BROWN HARD SPIRIT VARNISH.—1. Sandarach, 4 oz.; pale seed-lac, 2 oz.; elemi, 1 oz.; alcohol, 1 quart; digest with agitation till dissolved, then add Venice turpentine, 2 oz. 2. Gum sandarach, 3 lbs.; shellac, 2 lbs.; rectified spirit (65 over proof), 2 gallons; dissolve, add turpentine varnish, 1 quart; agitate well and strain. *Very fine.* 3. Seed-lac and yellow resin, of each 1½ lb.; rectified spirit, 2 gallons. 4. Gum juniper, 6 oz.; shellac, 6 oz.; salt of tartar, ½ oz.; Venice turpentine, 1½ oz., and 4 pints of spirits of wine mixed together.

TURPENTINE VARNISH.—To 1 pint of spirits of turpentine add 10 oz. clear resin pounded; put it in a tin can on a stove, and let it boil for half an hour.

When the resin is all dissolved, let it cool, and it is ready for use.

White Hard Spirit Varnish.—1. Gum sandarach, 1 lb.; clear turpentine, 6 oz.; rectified spirit (65 over proof), 3 pints; dissolve. 2. Mastic, in tears, 2 oz.; sandarach, 8 oz.; gum elemi, 1 oz.; Chio turpentine, 4 oz.; rectified spirit (65 over proof), 1 quart. Used on metals; polishes well. 3. Gum mastic, 4 oz.; gum juniper, ½ lb.; turpentine, 1 oz.; spirits of wine, 4 pints; mix together.

Mastic Varnish.—1 pint spirits of turpentine, and 10 oz. of the clearest gum mastic. Set it in a sand bath till it is all dissolved, then strain it through a fine sieve, and it is ready for use; if too thick, thin with spirit of turpentine.

Soft Brilliant Varnish.—Sandarach, 6 oz.; elemi (genuine), 4 oz.; animé, 1 oz.; camphor, ½ oz.; rectified spirit, 1 quart; as before.

Sealing-wax Varnish.—Dissolve sealing wax in spirits of wine, and apply the solution (well shaken up) with a soft brush; the spirits of wine will evaporate, leaving an even coating of sealing wax.

Etching Varnishes.—White wax, 2 oz.; black and Burgundy pitch, of each ½ oz.; melt together; add by degrees powdered asphaltum 2 oz., and boil till a drop taken out on a plate will break when cold by being bent double two or three times between the fingers; it must then be poured into warm water and made into small balls for use.

Hard.—Linseed oil and mastic, of each 4 oz.; melt together.

Soft.—Soft linseed oil, 4 oz.; gum benzoin and white wax, of each ½ oz.; boil to two-thirds.

Linseed-oil Varnish.—Boil linseed oil, 60 parts, with litharge, 2 parts, and white vitriol, 1 part, each finely powdered, until all water is evaporated. Then set by. Or, rub up borate of manganese, 4 parts, with some of the oil, then add linseed oil, 3000 parts, and heat to boiling.

Bookbinders' Varnish.—1. 6 oz. mastic, in drops; 3 oz. coarsely-pounded glass, separated from the dust by a sieve; 32 oz. spirits of wine of 40°. Place the ingredients in a sand bath over a fire, and let them boil, stirring them well. When thoroughly mixed introduce 3 oz. spirits of turpentine, boil for half an hour, remove from the fire, cool, and strain through cotton cloth. 2. 3 pints of spirits of wine of 40°; 8 oz. sandarach; 2 oz. mastic, in drops; 8 oz. shellac and 2 oz. Venice turpentine. Prepare as for No. 1. Apply lightly on the book with a piece of cotton wool, a small sponge, or a brush.

Varnish for Waterproof Goods.—Let a ¼ lb. of india-rubber, in small pieces, soften in ½ lb. of oil of turpentine, then add 2 lbs. of boiled oil, and boil for 2 hours over a slow fire. When dissolved, add 6 lbs. of boiled linseed oil, and 1 lb. of litharge, and boil until an even liquid is obtained. Applied warm.

Common Varnish.—Digest shellac, 1 part; with alcohol 7 or 8 parts.

Colourless Varnish, *with Shellac.*—Dissolve 2½ oz. of shellac in a pint of rectified spirits of wine; boil for a few minutes with 5 oz. of well-burnt and recently-heated animal charcoal. A small portion of the solution should then be filtered, and if not colourless, more charcoal added; when all the colour is removed press the liquor through a piece of silk, and afterwards filter through fine blotting paper. This kind of varnish should be used in a room at 60° Fahr., perfectly free from the least dust. It dries in a few minutes, and is not liable afterwards to chill or bloom. It is particularly applicable to drawings and prints that have been sized, and may be advantageously used upon oil paintings which are thoroughly hard and dry, as it brings out the colours with the purest effect.

Copal Varnish (*Spirit*).—1. Melt in an iron pan at a slow heat, copal gum, powdered, 8 parts, and add balsam capivi, previously warmed, 2 parts. Then remove from the fire, and add spirits of turpentine, also warmed beforehand, 10 parts, to give the necessary consistence. Gum copal is made more

soluble in spirits of turpentine by melting the powdered crude gum, and allowing it to stand for some time loosely covered. 2. Pounded copal, 24 parts; spirits of turpentine, 40; camphor, 1. 3. Copal in powder, 16 parts; camphor, 2; oil of lavender, 90. Dissolve the camphor in the oil, heat the latter, and stir in the copal in successive portions until complete solution takes place. Thin with sufficient turpentine to make it of proper consistence. 4. Coarsely-powdered copal and glass, of each 4 oz.; alcohol of 90 per cent., 1 pint; camphor, ½ oz.; heat it in a water bath so that the bubbles may be counted as they rise, observing frequently to stir the mixture; when cold decant the clear. Used for pictures. 5. Copal melted and dropped into water, 3 oz.; gum sandarach, 6 oz.; mastic and Chio turpentine, of each 2½ oz.; powdered glass, 4 oz.; alcohol of 85 per cent., 1 quart; dissolve by a gentle heat. Used for metal, chairs, &c.

WHITE COPAL VARNISH.—4 oz. copal, ½ oz. camphor, 3 oz. white drying oil, 2 oz. essential oil of turpentine. Reduce the copal to powder, mix the camphor and drying oil, then heat it on a slow fire, and add the oil of turpentine, and strain.

BLACK VARNISH FOR STRAW HATS.—Best black sealing wax ½ oz.; rectified spirits of wine, 2 oz.; powder the sealing wax, and put it with the spirits of wine into a phial; digest them in a sand bath, or near a fire till the wax is dissolved; lay on warm with a fine soft hair-brush before a fire or in the sun.

DAMMAR VARNISH.—Gum dammar, 10 parts; gum sandarach, 5; gum mastic, 1. Digest at a low heat, occasionally shaking, with spirits of turpentine, 20 parts. Add spirits of turpentine until of the consistence of syrup.

VARNISH FOR GLASS.—Pulverize a quantity of gum adragant, and let it dissolve for 24 hours in the white of eggs, well beat up; then rub it gently on the glass with a soft brush.

VARNISH FOR POLISHED METAL.—1. Take bleached shellac, pounded in a mortar; place the bruised fragments into a bottle of alcohol until some shellac remains undissolved; agitate the bottle and contents frequently, and let the whole stand till clear; pour off the clear fluid. This forms the varnish. Warm the metal surface, and coat with a camel-hair brush. If not perfectly transparent, warm the varnished surface before a fire or in an oven until it becomes clear. Common orange shellac answers equally well, and for large surfaces even better, as it is more soluble than the bleached variety, and coats more perfectly, but care must be taken not to use the varnish insufficiently diluted. 2. Digest 1 part of bruised copal in 2 parts of absolute alcohol; but as this varnish dries too quickly it is preferable to take 1 part of copal, 1 part of oil of rosemary, and 2 or 3 parts of absolute alcohol. This gives a clear varnish as limpid as water. It should be applied hot, and when dry it will be found hard and durable. 3. Mix equal quantities of Canada balsam with very clear spirits of turpentine, until the whole is of the consistency of ordinary varnish, which can be determined by constantly shaking and allowing to settle. This may be applied without warming the varnish or the metal.

VARNISH FOR SILVER.—Gum elemi, 30 parts; white amber, 45; charcoal, 30; spirits of turpentine, 375. Used in a heated state; the metal to which it is to be applied being also heated.

VARNISH FOR IRON AND STEEL.—Dissolve 10 parts of clear grains of mastic, 5 camphor, 15 sandarach, and 5 of elemi, in a sufficient quantity of alcohol, and apply without heat.

VARNISH FOR BACKING POSITIVES.—Spirits of turpentine, 6 oz.; asphaltum, 2 oz.; white wax, 2 scruples; lamp-black, 1½ scruple. Dissolve in a warm place, and filter through flannel.

REMOVING VARNISH FROM PRINTS.—1. Begin at the corner of the print by rubbing up the varnish with the fingers: a fine white dust will be produced, which is the dry old varnish; proceed all over the print and wipe off this white dust with a rag. Repeat until the print has lost most or all of [illegible] rnish. Now

strain the print on a drawing board, size with weak parchment size; when dry size again with the same size; use the size half chilled; when perfectly dry apply mastic or other varnish. 2. Lay blotting paper on the print, and saturate with pure spirit, which will dissolve and the blotting paper absorb the varnish. Change the blotting paper, and repeat as often as may be needful.

INDIA-RUBBER VARNISH.—1. 2 oz. india-rubber finely divided, placed in a phial and digested in a sand bath, with ¼ lb. of camphene, and ¼ oz. of naphtha. When dissolved add 1 oz. of copal varnish, which renders it more durable. 2. Digest in a wide-mouthed glass bottle 2 oz. of india-rubber in shavings, with 1 lb. of oil of turpentine, during two days, without shaking, then stir up with a wooden spatula. Add another lb. of oil of turpentine, and digest, with frequent agitation, until all is dissolved. Mix 1½ lb. of this solution with 2 lbs. of white copal-oil varnish, and 1½ lb. of boiled linseed oil; shake and digest in a sand bath until they have united into a good varnish. 3. 4 oz. india-rubber in fine shavings dissolved in a covered jar by means of a sand bath, in 2 lbs. of crude benzole, and then mixed with 4 lbs. of hot linseed-oil varnish and ½ lb. of oil of turpentine. Dries well.

VARNISH FOR GAS BALLOONS.—Take india-rubber and dissolve it in 5 times its weight of spirits of turpentine, keeping them some time together, then boil gently 1 part of this solution with 8 parts of boiled linseed oil for a few minutes, strain and set aside to cool. It must be applied warm.

VARNISH BRUSHES. — All varnish brushes ought to be made of long white hairs of the best quality, and, for the general purposes of varnishing, have a good regular spring, with about one-fourth or fifth part worn off, flat, sharp, and thin at the point, so as to lay on the varnish smoothly and regularly. As the beauty of varnishing depends in a great measure on the brush as well as the manner of laying it on, great care is also necessary that no *oil brush* be put into varnish; therefore, all brushes worn down in oil colour, and intended to be put into varnish, ought previously to be well washed in turpentine, squeezed and dried with a clean linen rag, or well washed with soap and hot water, rinsed in clean warm water, and made perfectly dry. The best method of keeping oil-varnish brushes, when not in use, is to bore a hole through the handle and put a wire skewer through it, and so suspend the brush, in a narrow tin pot containing varnish of the same sort as it was last in, taking care that the varnish in the pot covers the hairs of the brush up to the binding, and no higher. Brushes so kept are always straight, clean, pliable, and in good order; whereas varnish brushes kept in turpentine become hard and harsh, and however well stroked or rubbed out, there will still remain turpentine enough to work out by degrees, and spoil the varnishing, by causing it to run streaky or cloudy.

GREEN TRANSPARENT VARNISH.—Grind a small quantity of Chinese blue and chromate of potash together, and mix them thoroughly in common copal varnish thinned with turpentine. The blue and the chromate must be ground to an impalpable powder, and the tone of colour varied with the amount of each ingredient used. A yellow-green requires about twice the quantity of the chromate of potash to that of the Chinese blue.

GOLDEN VARNISH. — Pulverize 1 drachm of saffron and ½ drachm of dragon's blood, and put them into 1 pint spirits of wine. Add 2 oz. of gum shellac and 2 drachms of socotrine aloes. Dissolve the whole by gentle heat. Yellow painted work varnished with this mixture will appear almost equal to gold.

GUTTA-PERCHA VARNISH.—Clean a quarter of a pound of gutta-percha in warm water from adhering impurities, dry well, dissolve in 1 lb. of rectified resin oil, and add 2 lbs. of linseed-oil varnish, boiling hot.

Choosing Gums and Spirits.—In purchasing gum, examine it, and see that it consists, for the most part, of clear transparent lumps, without a mix-

ture of dirt; select the clearest and lightest pieces for the most particular kinds of varnish, reserving the others, when separated from extraneous matter, for the coarser varnishes. In choosing spirits of wine, the most simple test is to pour a small quantity into a cup, set it on fire, and dip a finger into the blazing liquid; if it burns quickly out, without burning the finger, it is good; but if it is long in burning, and leaves any dampness remaining on the finger, it is mixed with inferior spirit; it may be also compared with other spirit, by comparing the weight of equal quantities, the lightest is the best. The goodness of spirits of turpentine may be likewise ascertained by weighing it, and by noticing the degree of inflammability it possesses; the most inflammable is the best; and a person much in the habit of using it will tell by the smell its good or bad qualities; for good turpentine has a pungent smell, the bad a very disagreeable one, and not so powerful.

LAC-WATER VARNISH. — Pale shellac, 5 oz.; borax, 1 oz.; water, 1 pint. Digest at nearly the boiling point till dissolved, then strain. An excellent vehicle for water colours, inks, &c., and a varnish for prints is made thus of bleached lac. When dry, it is transparent and waterproof.

To Bleach Lac.—Dissolve shellac in a lye of pearlash by boiling; filter, pass chlorine through it in excess, wash and precipitate; afterwards melt it into sticks. This makes an excellent varnish with spirits of wine; its colour also renders it good for white and delicate-coloured sealing wax.

Lacquering.—This is done in two ways, called cold lacquering and hot lacquering. By the former, a little lacquer being taken on a common camel-hair varnish brush, is laid carefully and evenly over the work, which is then placed in an oven or on a hot stove; the heat from this continued only a minute or two is sufficient to set the lacquer, and the work is finished. Care must be taken not to have the work too hot so as to burn the lacquer, nor yet too cold, for in this case the lacquer will not be thoroughly set. By the second method, the work is heated first to about the heat of a flat iron as used by the laundress, and the lacquer quickly brushed over it in this state, the work being subjected to the oven for a minute afterwards or not, according to the pleasure and judgment of the lacquerer. The article, if very small, will require this, because it will have parted with most of its heat in laying on of the lacquer; if heavy, it will retain sufficient to perfect the process. The greatest difficulty is to know the exact degree of heat, and this knowledge cannot be attained except by experience, so different is the nature of the materials, the quality of different lacquers, and the effect to be produced.

TO PREPARE BRASS FOR LACQUERING.—As the object of lacquering is not to give a brilliancy, but to preserve one already obtained, it will be evident that in the preparation of anything the brighter surface obtained the better. Some goods are turned in the lathe, and then polished; sometimes, as in philosophical instruments, burnished also; this makes them sufficiently bright. Other goods, s, for example, such as have chased surfaces, and cannot therefore be turned with a cutting tool, are held against a scratch brush or brush of wire, which is fixed to the lathe like a chuck, and is made to revolve rapidly. This removes all asperities and renders the surface fit to receive the lacquer. A third and more common process is, after the surface is got by other means as clean as possible, to put the goods into pickle, that is, into aquafortis and water, and leave them there for some hours, according to circumstances. The acid eats away the outer coat, leaving a bright surface beneath. The goods are now put into hot saw-dust, and shaken about to dry and clean them, when they will be ready for lacquering. A very convenient plan for keeping the saw-dust warm and dry is to place it in an iron box, under which a number of gas-jets are kept lighted. See *Brightening and Colouring Brass*, p. 16.

RE-LACQUERING BRASSWORK.—After taking the work to pieces, and carefully

removing all iron screws and pins, boil off the old lacquer in a lye made by mixing ½ lb. of potash with 1 gallon of water. Allow the work to remain in this lye about twenty minutes; then plunge into clean cold water, when the whole of the old lacquer will be found to have been removed. The next process is to dip the work in aquafortis, or dipping acid; and the greater the specific gravity of this the better, particularly for old work. The larger pieces are dipped by means of a pair of brass tongs, and the smaller ones by twisting them on copper wire. When they have remained in the acid long enough to become quite bright and clean, plunge them quickly into clean cold water; it is best to have two or three vessels of water, rinsing the work in all of them. When the work comes out of the last supply of water, it is transferred to the saw-dust box, and when dry is ready for lacquering.

LACQUER FOR BRASS.—1. Seed-lac, dragon's blood, annatto, and gamboge, of each 4 oz.; saffron, 1 oz.; spirits of wine, 10 pints. 2. Turmeric, 1 lb.; annatto, 2 oz.; shellac and gum juniper, of each 12 oz.; spirits of wine, 12 oz. 3. Seed-lac, 6 oz.; dragon's blood, 40 grs.; amber or copal (ground on porphyry), 2 oz.; extract of red sandalwood, 30 grs.; oriental saffron, 36 grs.; pulverized glass, 4 oz.; purest alcohol, 40 oz. 4. Seed-lac, 3 oz.; amber and gamboge, of each 2 oz.; extract of red sanders, ½ dr.; dragon's blood, 1 dr.; saffron, ½ dr.; spirits of wine, 2 pints 4 oz. 5. Turmeric, 6 drs.; saffron, 15 grs.; spirits of wine, 1 pint 4 oz.; draw the tincture, add gamboge 6 drs.; gum sandarach and gum elemi, each 2 oz.; dragon's blood and seed-lac, of each 1 oz. 6. Put into a pint of alcohol, 1 oz. of turmeric powder, 2 drs. of annatto, and 2 drs. of saffron; agitate during 7 days, and filter into a clean bottle. Now add 3 oz. of clean seed-lac, and agitate the bottle every day for 14 days. 7. ½ oz. gamboge, 1½ oz. aloes, 8 oz. fine shellac, 1 gallon spirits of wine.

PALE LACQUER.—1 gallon of methylated spirits of wine, 5 oz. of shellac, 4 oz. of gum sandarach, and 1 oz. of gum elemi; mix in a tin flask and expose to a gentle heat for a day or two, then strain off, and add ½ gallon of spirit to the sediment, and treat as before.

GREEN LACQUER.—Add to the pale lacquer when mixing, 6 oz. of turmeric, and 1 oz. of gum gamboge.

PALE GOLD LACQUER.—1 gallon of methylated spirits of wine, 10 oz. of seed-lac bruised, and ½ oz. of red sanders; dissolve and strain.

LACQUER FOR TIN.—Put 3 oz. of seed-lac, 2 drs. of dragon's blood, and 1 oz. of turmeric powder, into a pint of well rectified spirits. Let the whole remain for 14 days, but during that time agitate the bottle once a day at least. When properly combined, strain the liquid through muslin. It is brushed over tin-ware which is intended to imitate brass.

LACQUER FOR PHILOSOPHICAL INSTRUMENTS.—Take ¾ oz. of gum guttæ (or gamboge), 2 oz. of gum sandarach, 2 oz. of gum elemi, 1 oz. of dragon's blood, 1 oz. of seed-lac, 2 grs. of oriental saffron, and 20 oz. of pure alcohol. The tincture of saffron is obtained by infusing in alcohol for twenty-four hours, or exposing to the heat of the sun in summer. The tincture must be strained through a piece of clean linen cloth, and ought to be strongly squeezed. This tincture is poured over the dragon's blood, the gum elemi, the seed-lac, and the gum guttæ, all pounded.

HIGH-COLOURED LACQUER.—2 quarts spirits of wine, 2½ oz. shellac, 2 oz. gum sandarach, ½ oz. gum elemi; mix and keep gently warmed for two or three days; strain, colour with dragon's blood to taste, and thin with 1 quart spirits of wine.

CHINESE LACQUER-WORK.—Chinese lacquer-work is done over tin-foil, and consists of a mixture of 2 parts of copal, and 1 of shellac, melted together. When fluid, there are added 2 parts of boiled linseed oil; and, after the vessel containing this mixture has been taken from the fire, there are gradually added 10 parts of oil of turpentine. If colour is required, gum guttæ (or gamboge), dissolved in oil of turpentine, yields yellow; and dragon's blood, dissolved in the same liquid, yields red.

Japanning.—To prepare goods for japanning, they are occasionally coated with a priming, for the purpose of filling up inequalities, and making smooth the surface to be japanned, but commonly the priming is omitted, the coloured varnish or japan ground being applied immediately to the substance to be japanned. The former is the method practised when the surface is very uneven and rough; but when the surface is smooth, as in the case of metals or smooth-grained wood, it is now always rejected. The priming or undercoat makes a saving in the quantity of varnish used, but the japan coats of varnish and colour are liable to be cracked and peeled off by any violence, and will not endure so long as bodies japanned in the same manner without priming.

To Prepare Work for Japan *with Priming*.—Take size of a consistency between common double size and glue, and mix with as much whiting as will give it a good body, so as to hide the surface of whatever it is laid upon; for particularly fine work use glovers' or parchment size, to which add one quarter of isinglass. The work is prepared for this priming by being well cleaned, and brushed over with hot size, diluted with two-thirds water; the priming is then laid on with a brush as evenly as possible, and left to dry. If the surface on which the priming is used is tolerably even, two coats will be sufficient; but if on trial with a wet rag it will not receive a proper water polish, one or more coats must be given it. Previous to the last coat being laid on, smooth with fine glass paper. When the last coat is dry, give the water polish by passing over every part of it with a fine rag or sponge moistened, till the whole appears plain and even; the priming will then be completed, and the work ready to receive the japan ground. *Without priming*, lay on two or three coats of varnish composed of rectified spirits of wine 1 pint, coarse seed-lac and resin, each 2 oz. This varnish, like all other formed of spirits of wine, must be laid on in a warm place, and all dampness avoided; for either cold or moisture chills it, and prevents its taking proper hold of the substance on which it is laid. When the work is thus prepared, the proper japan ground must be laid on.

Japan Grounds.—The proper japan grounds are either such as are formed by the varnish and colour, where the whole is to remain of one simple colour, or by the varnish with or without colour, on which some painting or other decoration is afterwards to be laid. This ground is best formed of shellac varnish, and the colour desired. Any pigments whatever may be used with the shellac varnish, which will give the tint of the ground, and they may be mixed together to form any compound colours; but, with respect to such as require peculiar methods for producing them of the first degree of brightness, we shall particularize them below. They should all be ground very smooth in spirits of turpentine, and then mixed with the varnish. It should be spread over the work very carefully and even with a camel-hair brush. As metals never require the priming of size and whiting, the japan ground may be applied immediately to them, without any other preparation than cleaning. Metals receive from three to five coats, and between each must be dried in an oven heated from 250° to 300°.

Black Japan Grounds.—1. Mix shellac varnish with either ivory-black or lampblack; but the former is preferable. These may be always laid on with the shellac varnish, and have their upper or polishing coats of common seed-lac varnish. 2. A common black japan may be made by painting a piece of work with drying oil, and putting the work into a stove, not too hot, but of such a degree as will change the oil black without burning it, gradually raising the heat and keeping it up for a long time. This requires no polishing. 3. Asphaltum, ½ lb.; melt, then add hot balsam of capivi, 1 lb., and when mixed, thin with hot oil of turpentine. 4. Grind lampblack very smooth on a marble slab with a muller with turpentine, and then add copal varnish to the proper consistency. 5. Asphaltum, 3 oz.; boiled oil, 4 quarts; burnt umber, 8 oz. Mix by heat, and

when cooling thin with turpentine. 6. Amber, 12 oz.; asphaltum, 2 oz.; fuse by heat, add boiled oil ½ pint, resin 2 oz.; when cooling add 16 *oz.* oil of turpentine.

WHITE JAPAN GROUNDS.—Flake-white, or white-lead, washed and ground up with the sixth of its weight of starch, and dried; temper properly for spreading with mastic varnish. Lay on the body to be japanned, then varnish over it with 5 or 6 coats of the following varnish:—Seed-lac, 2 oz.; gum anime, 3 oz.; reduce the gums to a coarse powder, dissolve in about a quart of spirits of wine, and strain off the clear varnish. The seed-lac will give a slight tinge to this composition; but it cannot be omitted where the varnish is wanted to be hard, though where a softer will answer the end the proportion may be diminished, and a little crude turpentine added to the gum anime to take off the brittleness.

BLUE JAPAN GROUNDS may be formed of bright Prussian blue, or of smalt. The colour may be mixed with shellac varnish; but as shellac will somewhat injure the colour by giving it a yellow tinge, where a bright blue is required the method directed in the case of white grounds must be pursued.

RED JAPAN GROUND.—The base of this japan ground must be made up with madder lake, ground with oil of turpentine; this forms the first ground; when perfectly dry, a second coat must be applied, composed of lake and white copal varnish; and the last with a coat composed of a mixture of copal and turpentine varnish mixed up with lake. Vermilion or carmine can also be used for red japan instead of lake.

YELLOW JAPAN GROUNDS.—1. King's yellow may be used, and the effect will be heightened by dissolving powdered turmeric root in the spirits of wine, of which the upper or polishing coat is made, which spirits of wine must be strained from off the dregs before the seed-lac is added to it to form the varnish. 2. Saffron, crome yellow, or turmeric, dissolved in spirits of wine, strained, and mixed with pure seed-lac varnish.

GREEN JAPAN GROUNDS may be produced by mixing Prussian blue, or distilled verdigris, with king's yellow and a varnish, and the effect will be rendered extremely brilliant by laying on a ground of gold leaf.

ORANGE JAPAN GROUNDS may be formed by mixing vermilion or red-lead with king's yellow or orange lake; or red orpiment will make a brighter orange ground than can be produced by any mixture.

PURPLE JAPAN GROUNDS may be produced by the mixture of lake or vermilion with Prussian blue. They may be treated as the rest with respect to the varnish.

TORTOISESHELL JAPAN.—Linseed oil, 2 pints; umber, ¼ lb.; boil together until the oil becomes very brown and thick; strain through a cloth and boil again until the composition is about the consistence of pitch, when it is fit for use. Having prepared this varnish, clean well the article that is to be japanned, and then lay vermilion, mixed with shellac varnish, or with drying oil, diluted with turpentine, very thinly on the places intended to imitate the clear parts of the tortoiseshell. When the vermilion is dry, brush over the whole with the above umber varnish diluted to a due consistence with turpentine, and when it is set and firm it must be put into a stove and undergo a strong heat for a long time, even two weeks will not hurt it.

PAINTING JAPAN-WORK.—The preparation of colours for japan-work consists in bringing them to a due state of fineness, by grinding on a stone in oil of turpentine. The best varnish for binding and preserving the colours is shellac; this, when judiciously managed, gives such a firmness and hardness to the work, that, if it be afterwards further secured with a moderately thick coat of seed-lac varnish, it will be almost as hard and durable as glass. Painting in varnish is, however, more tedious than in oil or water; it is therefore now usual in japan-work, for the sake of dispatch, and in some cases for the freer use of the pencil, to lay on the colours with *japanners' gold size.* The colours are also sometimes laid on in gum water, but

the work done in this manner is not so durable as that done in varnish or oil. Water colours are sometimes laid on grounds of gold, in the manner of other paintings, and look best without any varnish over them; and they are sometimes so managed as to have the effect of embossed work. The colours in this way of painting are prepared by means of isinglass size corrected with honey or sugar-candy. The body with which the embossed work is raised is best formed of strong gum water, thickened to a proper consistence with bole armenian and whiting, in equal parts; which, being laid on in the proper figures and repaired when dry, may be then painted with the intended colours tempered in the isinglass size, or in the general manner with shellac varnish.

VARNISHING JAPAN-WORK.—The finishing process in japanning consists in laying on and polishing the outer coats of varnish, which are equally necessary, whether the japan ground is painted or not. The pieces of work to be varnished should be placed near the fire, or in a warm room made perfectly dry, and the varnish laid on with a flat camel-hair brush made for the purpose: the varnishing must be done rapidly, but with great care; the same place should not be passed twice over in laying on one coat if it can possibly be avoided: the best way of proceeding is to begin in the middle, pass it to the other end, taking care that, before each stroke, the brush is well supplied with varnish. When one coat is dry, another must be laid over it in like manner, and this must be continued at least five or six times. It greatly improves all kinds of japan-work to harden the varnish by means of heat, which, in every degree that it can be applied short of what would burn or calcine the matter, tends to give it a firm texture. Where metals form the body therefore, a very hot oven may be used, and the work may be continued in it a considerable time, especially if the heat be gradually increased; but where wood or papier maché is in question, heat must be sparingly used after each coat of varnish. If, on trial, there be not a sufficient thickness of varnish to bear the polish without laying bare the painting or ground colour underneath, more must be laid on. When a sufficient number of coats is laid on, the work is fit to be polished, which must be done, in common cases, by rubbing it with a piece of cloth or felt dipped in Tripoli or pumice-stone finely powdered. But towards the end of the rubbing a little oil of any kind should be used with the powder, and when the work appears sufficiently bright and glossy, it should be well rubbed with the oil alone to clean it from the powder and give it a still greater lustre. In the case of white grounds, instead of the Tripoli fine putty or whiting should be used, but they should be washed over to prevent the danger of damaging the work from any sand or other gritty matter that may happen to be mixed with them.

Tunbridge Ware. *Body.*—The articles are usually made of either horse-chestnut or sycamore wood, the whiter the better, and should be well finished off with glass paper; wipe them and give them one coat of spirit varnish; this raises the grain; rub down with fine glass paper when dry; wipe from the dust, and varnish again with *white hard spirit varnish*, and they are properly prepared for painting; but prints or drawings must be put on previous to this preparation. In preparing articles for ladies to paint on, as they use water colours instead of copal colours, omit the two coats of spirit varnish, using instead a white varnish made of finely-powdered flake-white and isinglass size, used hot, rubbed down in the same way and repeated.

Painting.—The colours used are the same as for oil painting, but in a dry state; they are to be ground fine in turpentine, let dry, and are then fit for use; some of the smooth colours, as vermilion, lampblack, &c., do not require grinding in turpentine first. The colours are mixed on a palette or marble slab rather stiff with copal varnish and thinned for use with turpentine; they require copal varnish enough to make

them bind and dry firm and work free, but not enough to make them shining or sticky. When gilding is wished, use Japan gold size, bearing in mind that any ground colour, imitation wood, &c., upon which gold ornaments are to appear, must have one coat of spirit varnish over it before sizing, which is necessary also when objects are painted on a black or other coloured ground—the spirit varnish preventing the ground colour from working up. Coloured prints or drawings on paper, pasted close and tight on the wood, form a pretty centre; they must always be sized with isinglass size twice over before they are varnished over with the spirit varnish. Have a little cup of turpentine by you when painting to moisten the camel-hair pencils, and make them work free; wash them in turpentine, and keep the colours from the air as much as possible.

Varnishing.—After the article is ornamented or painted, it must have a square block of wood, according to its size, and from 4 to 6 in. long, glued slightly on the bottom, to serve as a handle in the future process. It must then receive from 6 to 8 coats of *white hard spirit varnish;* this should occupy two days; let it remain the following night in the varnish room, that it may set gradually, and then remove it to an airy place; the more current of air, providing neither damp nor sun can get at it, the better; let it remain here about a fortnight if you wish your work to stand well. When quite hard, the varnish will crack all over in very minute cracks.

Rubbing Down.—To do this, provide yourself with some very finely grated chalk, perfectly free from grit, and a rubber made of *stuff* doubled flat five or six times round a piece of very stiff pasteboard, also a pan of clean water; fix the article by the block in a vice, or any way convenient, soak the rubber in water, then, while wet, cover it with the grated chalk dry, and with it rub the article to and fro, and afterwards crossways, till the cracks are all removed and the surface is perfectly flat and even, continually dipping the rubber in water, and taking fresh dry chalk, but keeping the rubber wet and the hands also, to prevent the varnish printing; wipe off occasionally with the palm of the hand to observe the progress and prevent rubbing through. Be careful not to touch it with the hands dry, as the rubbing softens the varnish; when smooth and even all over, stand by for about a week.

Polishing and Finishing.—This is done in the same way as the rubbing down with dry chalk and water, only using a woollen cloth rubber instead of the stuff one, and less chalk; and the finishing or smoothing is done with the palm of the hand wet, without any rubber at all. When the required polish or brightness is obtained, which takes but very little time, as it is supposed to be perfectly flat, smooth, and even, from the rubbing down, and the polishing is only to give a brightness to the surface by a delicate and very slight friction on the varnish, now thoroughly hard and even. Stand it by till the next day, then knock off the block, scrape any of the unvarnished parts where the chalk and water may have soaked in. Line the inside with silk, satin, velvet, tin-foil, or paper, according to the nature of the article; then oil all over the polished parts with a piece of flannel soaked in Florence oil; clean and finish off with a very soft cotton or silk duster and common flour; dry, and if well done, it will look almost like plate glass.

Carriage Japan.—40 gallons raw linseed oil, 40 lbs. litharge, 20 lbs. red-lead, 10 lbs. black oxide of manganese, 2 lbs. white gum shellac. Set the oil over the fire and bring to the boiling point; add by degrees litharge and red-lead alternately and slowly; add the gum, and when this is melted put in the manganese, and keep the whole in rapid motion from the time the oil is 200° Fahr. until the making is finished. When the mixture is cool enough to bear the finger in a moment, add from 20 to 30 gallons spirits of turpentine.

Carriage Painting. — Carriage painting should be conducted in a room where dust can be entirely excluded, and where ready means of ventilation are

always at hand. The following receipts will give the mode of working both with boiled oil and with raw oil as a vehicle, the exclusive use of either oil being a very disputed question. When the woodwork of a carriage comes into the shop examine it closely, and if the grain has raised in any place, or it wants smoothing with sand paper, be sure and do it before priming the work.

Priming.—For the priming coat use white-lead mixed in prepared raw oil and one-eighth part turpentine, with a shade of lampblack if the carriage is to be a dark colour. The less paint used in priming the better, taking care not to leave it thick upon the edge, or to collect upon the mouldings, but going well over cracks, cheeks, and screw-heads, so that they have at least one coat of paint over the surface which is to be puttied up.

Second Coat.—After the priming has been four days drying, and has then been sand-papered off, give another coat of the same paint used for priming with a little drier, and about one-fourth as much turpentine as oil. Sometimes a third coat is applied. When thoroughly hard, fill in all screw-heads and places to be stopped with putty made of whiting and good drying varnish.

Rough Stuffing.—7 parts, yellow ochre; 1, white-lead; 4, good drying varnish; 1, japan, and about $\frac{1}{15}$th as much raw oil as of copal varnish and japan together; mix, and grind with a muller, or run through a colour mill. After grinding reduce with turpentine, so that it works easily under the brush; apply several coats, each of which will take five or six days to dry. A carriage body will require at least three coats, but smaller vehicles need have but one.

Rubbing Down.—The object of rubbing down is to have a smooth surface free from dents, grains of the wood, tool marks, or anything in the way of making a fine even surface to put the finishing coat of paint on. Saw pumice-stone into blocks of a suitable size, shaping pieces of stone with a small round file to fit the beads. Wet the work with a sponge, and with a wet block of pumice-stone rub until the parts are smooth and level, using the wet sponge frequently to clean the paint and ascertain whether it is rubbed enough. When the brush marks are all rubbed out of the rough stuffing, the rubbing may be considered finished.

Colouring.—After rubbing down apply a coat of lead-colour ground very fine in a paint mill. When this is dry, rub down again very closely with fine sand paper; examine, putty up places neglected in former puttyings, &c.; stand by to harden, and again rub with pumice-stone. Supposing the colour wished for is ultramarine blue, mix up white-lead and Chinese blue to the required tint with 3 parts japan and 1 part oil, put on, dry, and rub down with moss or a linen rag. Colour, if black, mix it with 1 part oil and 3 parts japan; if a transparent colour, thin it with sugar of lead and raw linseed oil, and let it dry. Colour, dry, then give from three to four coats of varnish. Observe that between every coat of colour the paint should be well rubbed with woollen cloth and ground pumice-stone. The striping should be laid on before the varnish is applied.

Ironwork.—The ironwork of a carriage should have two coats of oil lead colour, sand paper well, give one coat more, after which give one coat best oil black, two coats black japan, a slight rubbing, and a flowing coat of varnish.

Varnishing and Polishing.—Good coach bodies are seldom polished with less than five or six coats of varnish. The work should be so ordered that decorations, heraldic devices, and so on, have at least two coats of varnish over them. Cheap work intended to be finished with one coat of varnish ought to be laid on rather full and flowing; but if two coats are intended, the first coat should be laid more sparingly, and the second applied the third day after; and in cases where a third coat is applied, the second coat ought previously to be rubbed down to nearly a dead flat with ground pumice dust and water. If it is to be afterwards polished, let it stand at least fourteen days; then take a very fine pumice dust, well sifted through a very fine silk or muslin sieve, wet the work with a brush and clean water, have ready some pieces

of white woollen cloth, folded up in a proper manner, dip a piece in water and then in the pumice dust, begin and rub down the work from top to bottom with a regular pressure, bearing steadily but rather lightly, rubbing the work as nearly all alike as possible, because on that particular depends the beauty of the polishing; wash off from time to time with a sponge and water during the polishing, till with the palm of the hand rubbed two or three times in the same place, the work discover its polish; then with a bit of serge or flannel, dipped in refined linseed oil, rub the work over, and afterwards clean it off with the hand, or a piece of fine leather, dipped in fine dried powder or flour. When cleared of the oil, a piece of fine flannel, dipped in dry flour and rubbed over it, will give it beauty and lustre. Varnishing must be conducted in a warm, dry atmosphere, kept very equable in temperature; it is therefore a good plan always to have a warm stove in the varnishing room. Coach painters are aware that some copal varnishes will answer very well upon one coach body, but when applied upon another will sink in dead, fall into pin-holes, or be otherwise faulty, and are at a loss how to account for such failures; they are not merely the effect of chance, but more frequently occur from the want of the necessary knowledge of oils, colours, and varnishes; for instance, when any piece of work is painted with a hard, solid, heavy, compact metallic or mineral colour, such as white-lead, patent yellow, &c. The grounds are then firm, close, and solid; and almost any copal varnish will look well, appear brilliant, stand polishing well, and sooner, than on any other grounds; it will last, however, but a short time, for if the varnish is deficient in gumminess, the metallic colour will imbibe the virtue of the varnish and cause its decay. The same varnish applied upon green grounds, which are much more absorbent, will sink in *sleepy* or dead, not having a sufficient oily and gummy body. Therefore it is necessary that every painter should be acquainted with the nature of his grounds, and procure his varnish accordingly, namely for hard, compact, solid grounds, a strong, gummy, tough, but flowing varnish; and for all soft absorbent grounds, such as compound greens, lakes, browns, drabs, a soft, strong, oily, free-flowing varnish. Copal varnishes, which abound with oil and gum, are those fittest for all sorts of coach-work, as they possess firmness, toughness, and durability; yet they are slower in drying, and must stand some time before they will bear polishing; whereas all hard brittle varnishes will dry firm and hard, bear polishing very soon, but afterwards crack and fade all over. Coach painters ought to use the best polishing body copal for bodies, and even for carriage-work, where the colours are very pale and delicate, or at least lay the last coat with body varnish. Where the work is dark, there is no occasion to fear using a middling dark carriage varnish, as it is often better than the pale. Amber varnish is often used for varnishing black grounds or black japan, as possessing peculiar properties; besides, it is easy to lay on.

To Prepare Raw Oil.—Add $\frac{1}{5}$th part good brown japan to 4 parts raw linseed oil. If paint requires any further drier, $\frac{1}{2}$ oz. sugar of lead and $\frac{1}{2}$ oz. white vitriol ground together can be added to each pound of paint.

Yellow Colours.—When a coach is to be painted pale yellow, take 3 lbs. of dry white-lead, 1 lb. of whiting, $\frac{1}{2}$ lb. of litharge, $\frac{1}{2}$ lb. of pale spruce ochre, all well dried; grind with 3 parts raw oil, 1 part turpentine; add sufficient gold size to make it dry, firm, and hard; as soon as dry, sand-paper and putty up the work with hard putty, then prepare a sufficient quantity of the above colours; apply 3 coats, rubbing down with care; after these apply a fourth, and if necessary a fifth coat, made of 3 lbs. of dry white-lead, $\frac{1}{4}$ lb. of dry spruce ochre, $\frac{1}{4}$ lb. of pumice-stone, all well ground with 3 parts raw oil, 2 parts turpentine, adding a little pale gold size to dry it firm and hard. When dry and rubbed down, apply the finishing coat, pale patent yellow, ground in 4 parts prepared oil, 1 part turpentine; and 1 coat,

if well laid, looks always more clear and bright than when 2 are applied. The above being a mineral metallic colour, it is compact, firm, and durable, and will dry sooner, firmer, and harder, as well as bear out and support varnishing and polishing better, than most other colours.

LAKE COLOURS.—If a coach is to be finished of a lake colour, proceed with the first four or five applications exactly as for yellow; then take dry white-lead, ground with half oil and half turpentine, stain it with Indian red, and add a little gold size. When dry and hard, rub it very smooth; then apply another coat of good Indian red, ground in prepared oil and turpentine, with very little gold size; next rub that very smooth, let it harden well, taking great care not to cut through the former coat; wash it clean off, wipe it perfectly dry, let it be as free from any moisture as possible, and then apply the finishing coat of pure lake, ground and worked in 4 parts prepared oil, 2 parts turpentine, with a little pale gold size, or else very pale boiled oil, to cause it to dry.

GREEN COLOURS.—In laying the finishing coat of any compound green on coach bodies, it is indispensably necessary that the colour be worked full, and laid off very smoothly and lightly, by working the brush perpendicularly from top to bottom; otherwise compound green colours will always appear shaded, and if highly varnished, the shades will be rendered more conspicuous. Several greens, from the nature of their component parts, will cause the varnish, however good and old, to ferment and fall into pin-holes. Prussian blue, when ground in oil without previous preparation, always becomes *livery*, as it is termed, in a short time, and is then unfit for use; this arises from the blue being composed of prussic acid and vitriol, which act on the oil. The strongest nitrous acid and acetate of lead are component parts of the chrome yellows; and all sorts of verdigris are made either by pyroligneous or vitriolic acids. All colours therefore which contain strong acids, whether mineral or vegetable, destroy the oils in which they are ground and applied, cause the whole body and brilliancy of the colour to fade, and even corrode and destroy the most durable varnishes. To guard against these effects, it is necessary in preparing Prussian blue to grind it very fine in pure soft water, and afterwards to pour on it plenty of boiling soft water, washing it well about, and allowing it to stand 8 or 10 hours to settle: the clear water must then be poured off the surface, and more boiling water poured on the blue, which must be washed as before, and when the colour has again settled, must be poured off, and the blue laid upon a linen filter to drain out the water. When the blue has become rather stiff, remove it on to chalk stones, or sheets of white paper, keeping it free from dust; dry it in the sun, if possible; but if not convenient, dry it very gradually by a stove. The more the blue is washed, the finer, softer, and more brilliant it becomes, and the freer it will be from acid.

Repainting Carriages.—Previous to repainting or revarnishing any old coach-work, it is necessary first to wash the work quite clean, and also to rub down the surface with a wet cloth and ground pumice powder, until it appears quite dead, or without gloss. The work should then be washed, and dried with a wash leather; after which it is fit to receive either paint or varnish. Old work is frequently dirty, greasy, and strongly impregnated with various exhalations, very injurious to paint-work and varnish from its being kept shut up in cold damp coach-houses, which have often doors or passages communicating with stables, latrines, and so on. If therefore it be repainted or revarnished, without having been well washed and rubbed down, it seldom or never dries properly, owing to the exhalations with which the surface is in general incrusted: and should the surface be even clear from grease, no paint or varnish will adhere, or can be well applied, on the old glossy surface, without its having been first rubbed down with the pumice powder and water, as that entirely removes all stains, grease,

and gloss from the surface. Paint or varnish will then adhere to the old ground, and can be easily worked and extended with the brush, without the colour *cissing*, as it is termed. Varnish is very apt to *ciss* on old work, if the second coat is not applied as soon as ever the first coat is hard enough to bear varnishing.

Carriage Japanning.—In order to lay a durable ground for finishing carriage-work with japan, examine all the work, particularly leather; see that it is free from oil, grease, or wrinkles; then prepare a priming colour, of equal parts of white-lead, red-lead, and spruce ochre, all well dried, and ground separately rather stiff in linseed oil; then mix the whole together, and add half a pint of gold size to each pound of colour, with as much turpentine as will cause the colour to work freely and easily. Brush the colour well out, rubbing it into every crack, joint, and crevice. As soon as this coat is dry, putty up all the cracks, and apply a second coat of the same colour. For the succeeding coats, grind equal parts of white-lead and spruce ochre rather stiff in half raw oil and turpentine; add as much vegetable lampblack as will change it to a dark lead colour; add to each pound ½ pint of good boiled oil, ¼ pint of gold size, and afterwards thin up the colour with turpentine for use, observing that the greater the quantity of turpentine which enters into the composition of the grounds, the less durable they become, and that if the quantity of raw oil was increased, the grounds would become more firm, solid, and durable, but would neither dry nor rub down so soon. All colours intended for old grounds ought to be prepared and used with as much oil as will give a firm, tough solidity. After the dark grounds are properly filled up, rubbed down smooth, and well cleaned, apply a coat of calcined lampblack, sifted very fine and mixed up with black japan, adding as much turpentine as will cause it to work freely. When this coat is dry and rubbed down, apply a finishing coat entirely of japan, without mixing it with varnish, which always causes japan to assume a green tint. Varnish with two or three coats of genuine amber varnish, which will not appear green, and is much more solid and durable than carriage copal varnishes generally are. Some painters put Prussian blue, verdigris, &c., into their last or finishing coat of japan, in order to keep down the *rustiness* of the japan; all such grounds are never black, but of a slatey grey hue, and, when viewed in wet or moist weather, appear all over of a bloom or greenish grey tint. Nothing more effectual can be done by the painter to improve the jetty blackness of japan than proper application, judicious rubbing down, varnishing, and afterwards polishing.

Carriage Graining. Pollard Oak.—The ground should be formed with patches of Vandyke brown. A softener should be drawn between the patches and the curls or knots formed by turning a short-cut hair pencil, or sponge, tied on the end of a stick between the thumb and finger. To render the work more showy, patches of lake and burnt terra de sienna may be put in. The graining colours are made of equal portions of burnt Turkey umber or Vandyke, raw terra de sienna and burnt copperas, ground separately in boiled oil or turps very stiff, and then mixed together, the whole thinned with spirits of turpentine. A very light coat should be rubbed on the panel with a large sash brush, and while wet a flat graining brush containing a very thin row of hairs should be dipped in the colour and dappled in a spirited manner in various directions. The brush should then be dipped in burnt umber made thin with turpentine, and some fine spirits thrown on. When the colours are set, take the same flat brush, dip it into a thin glaze of burnt umber, and put the grain on in a curly direction. A small part only of the surface should be finished at once, as the work will blend better if kept moist. It is necessary that a sufficient quantity of oil should be put into the colours to bind them.

Bird's-eye Maple.—The ground should be light buff, prepared with white-

lead, chrome yellow, and a little vermilion or Venetian red to tone the brightness of the yellow. The graining is made of equal parts of raw umber and terra de sienna ground to a proper consistence in ale. Spread the surface of the work with this colour, have some a little thicker prepared, and immediately take a sash tool or sponge and put on the dark shades, which may be softened with a badger-hair pencil. Before the colour is dry put on the eyes by dabbing with the dotter. When dry, put the grain on the prominent parts with a camel-hair pencil to imitate the small hearts of the wood. When the whole is quite dry apply the varnish.

Curled Maple.—For the ground mix chrome yellow, white-lead, and burnt terra de sienna. For the graining, equal parts of raw terra de sienna and umber, with a little burnt copperas, may be ground in turpentine and be mixed with a small quantity of grainers' cream. Thin the colour with boiled oil; then fill the tool, and spread the surface evenly. Rub out the lights with a piece of buff leather, which must be reasonably wiped to keep it clean. Soften the edges of the work very lightly, and when dry, put on the top grain with burnt umber and raw terra de sienna ground in ale, with the white of an egg beaten into it. When quite dry, varnish.

Varnishing and Polishing Fret-work.—The wood is first well smoothed with fine glass paper, then covered with a thin coating of size, made from transparent glue, to prevent the varnish from sinking into the wood. When dry, pour some varnish into a saucer; take a fine camel-hair brush, and commence to varnish at one corner, gradually spreading over the whole surface. Take care that there is not too much varnish on the brush, if it is applied otherwise an even surface cannot be obtained. The first coating must be allowed to dry, which will take two or three hours. Take a sheet of the finest glass paper, and when the first coating of varnish is perfectly dry, glass-paper the whole surface, and make it smooth as before. This done, with great care spread next coat of varnish on, always using the glass paper when the surface does not turn out very smooth. The whole, when dry, may be rubbed well with a piece of worn woollen till it is bright and smooth. To French polish the work, make the wood smooth as before. Then pour some prepared polish into a saucer, and some linseed oil into another. Then take some pieces of woollen rag, and roll them up into a ball, covering them with a piece of linen drawn tightly over. The rags inside should first be saturated with the polish, and the whole should be taken in the fingers of the right hand in such a way that the linen may be tightly drawn over, and may present to the wood a smooth rounded surface. Begin by polishing with free, circular strokes, and gradually traversing the whole surface. Apply now and then a drop of polish and a drop of oil to the surface of the rubber. When the grain of the wood disappears, allow it to stand for an hour or two till quite hard, and then glass-paper the whole as in varnishing. Repeat the process of polishing until the surface is quite smooth. If dull patches appear in the polish, they may be removed by a few drops of spirits of wine on a new rubber.

French Polishing.—As in varnishing, a warm, dry atmosphere is essential, and all draughts of cold air from door or window must be avoided.

Pour a little linseed oil into a cup and some polish into another; take a piece of woollen rag a few inches square, and having rolled it up into a ball saturate it with polish, and cover with a piece of linen or muslin drawn tightly over it. In this way the rubbers or pads are prepared, and they should, when taken by the fingers of the right hand, be held in such a manner as to draw the linen covering tight, and present a smooth, slightly convex surface to work with; apply one drop of oil and one drop of polish to the surface of the pad, and it is ready for use. Care must be taken that the material of which the rubbers are made is well washed and free from starch or soap. The work having been thoroughly smoothed with fine glass paper and the dust wiped away with a clean cloth, the

polishing is commenced with free, continuous and uniform circular strokes, applied with very slight pressure, and gradually traversing the whole surface, observing not to do more than a square foot at a time; the same process is repeatedly continued, varying the position of the strokes as much as possible, but keeping them about the same size, and taking care that every portion of the surface receives an equal but not excessive quantity of polish, which is regulated partly by the degree of pressure on the rubber, and partly by squeezing it between the fingers.

The process of polishing is continued until the grain of the wood appears to be thoroughly filled up, and the surface exhibits a uniform appearance, well covered with a thin coat of polish. It is then allowed to stand for an hour or two to become thoroughly hard, when it is rubbed with very fine glass paper, to smooth down all the irregularities of the grain of the wood, and also of the polish. The polishing is then repeated, and, if it should be found necessary, it is again smoothed, and the polishing is persevered in until the surface appears quite smooth, and uniformly covered with a thin and tolerably bright coat of polish, but which will, nevertheless, show cloudy marks from the rubber, owing to the presence of the oil, which is finally removed with a few drops of spirits of wine applied on a clean rubber and covered with a clean soft linen rag, with which the work is rubbed with very light strokes, applied first with a circular motion, and when the surface appears nearly dry, straight strokes are taken lengthways of the grain of the wood, and traversed entirely off the ends of the work; this is continued until the rubber and work are both quite dry, when the polishing will be completed. The polish, however, will be partly absorbed by the wood in the course of a day or two; and therefore it is desirable to repeat the process after a lapse of a few days, first slightly rubbing down the former coat with very fine or nearly worn-out glass paper.

Stopping for French Polishing.—Plaster of Paris, when made into a creamy paste, with water, proves a most valuable pore-filling material. It is to be rubbed by means of a coarse rag across the woody fibre into the holes and pores, till they be completely saturated, and then the superfluous stucco on the outside is to be instantly wiped off. The succeeding processes are technically termed papering, oiling, and embodying.

When finely-pounded whiting is slaked with painter's drying oil, it constitutes another good pore-filler. It is applied in the same manner as the preceding one, and it is recommended on account of its quickly hardening and tenacious virtues as a cement; sometimes white-lead is used in lieu of the whiting.

Before using either of these, or other compositions for the same purpose, it is best to tint them to correspond exactly with the colour of the article it is intended to size.

Holes and crevices may be well filled up with a cement that is made by melting beeswax in combination with resin and shellac.

Polishing Wood Carving.—Take a piece of wadding, soft and pliable, and drop a few drops of white or transparent polish or French polish, according to the colour of the wood. Wrap the wetted wadding up in a piece of old linen, forming it into a pad; hold the pad by the surplus linen; touch the pad with one or two drops of linseed oil. Pass the pad gently over the parts to be polished, working it round in small circles, occasionally re-wetting the wadding in polish, and the pad with a drop or so of oil. The object of the oil is merely to cause the pad to run over the wood easily without sticking, therefore as little as possible should be used, as it tends to deaden the polish to a certain extent. Where a carving is to be polished after having been varnished, the same process is necessary, but it can only be applied to the plainer portions of the work. Plane surfaces must be made perfectly smooth with glass paper before polishing, as every scratch or mark will show twice as badly after the operation. When the polish is first rubbed on the wood, it is called the *bodying in*; it will sink into the wood

and not give much glaze. It must, when dry, have another body rubbed on, and a third generally finishes it; but if not, the operation must be repeated. Just before the task is completed, greasy smears will show themselves; these will disappear by continuing the gentle rubbing without oiling the pad.

Polishing or Oiling Planes.—Planes made from naturally dried beechwood are much lighter in colour than those made from artificially dried or steamed beech. For planes made of the first-named beech, use raw linseed oil, 1 gill; dragon's blood, 1 pennyworth; yellow ochre, as much in bulk as dragon's blood; mix these together, and rub the planes all over except the sole or bottom; let them remain about a week. Take them and rub well all over with a clean soft rag; give one more coat of oil alone. Let it dry for three or four days, then rub well with a clean rag; lay them by for a week or two; rub again with rag, and use them if wanted. Let care be taken to keep them free from dust while the oil is wet, or they will be a dirty colour. For steamed beech proceed the same, except not to use more than about half the quantity of dragon's blood.

French Polish.—1. 1 pint of spirits of wine, ¼ oz. of gum copal, ¼ oz. of gum arabic, and 1 oz. of shellac. Bruise the gums and sift them through a piece of muslin. Place the spirits and the gums together in a vessel closely corked, place them near a warm stove, and frequently shake them; in two or three days they will be dissolved. Strain through a piece of muslin, and keep it corked tight. 2. Shellac, 6 oz.; naphtha, 1 quart; benzoin, ⅔ oz.; sandarach, 1 oz. 3. Dissolve 1½ oz. shellac, ¼ oz. sandarach, in ½ pint naphtha. To apply the polish fold a piece of flannel into a sort of cushion, wet it well with the polish, then lay a piece of clean linen rag over the flannel, apply one drop of linseed oil; rub your work in a circular direction lightly at first. To finish off, use a little naphtha applied the same as the polish. 4. Pale shellac, 2¼ lbs.; mastic and sandarach, of each 3 oz.; spirits, 1 gallon. Dissolve, and add copal varnish, 1 pint; mix well by agitation. 5. Shellac, 12 oz; wood naphtha, 1 quart; dissolve, and add ½ pint of linseed oil. 6. Crush 3 oz. of shellac with ½ oz. of gum mastic, add 1 pint of methylated spirits of wine, and dissolve. 7. Shellac, 12 oz.; gum elemi, 2 oz.; gum copal, 3 oz.; spirits of wine, 1 gallon; dissolve. 8. Shellac, 1¼ oz.; gum juniper, ½ oz.; benzoin, ½ oz.; methylated alcohol, ½ pint. 9. 1 oz. each of gums mastic, sandarach, seed-lac, shellac, and gum arabic, reduce to powder; then add ¼ oz. virgin wax; dissolve in a bottle with 1 quart rectified spirits of wine. Let it stand for 12 hours, and it is then fit for use. 10. 1 oz. gum-lac; 2 drs. mastic in drops; 4 drs. sandarach; 3 oz. shellac; ½ oz. gum dragon. Reduce the whole to powder.

French Polish Reviver.—1. Linseed oil, ½ pint; spirits of camphor, 1 oz.; vinegar, 2 oz.; butter of antimony, ½ oz.; spirit of hartshorn, ¼ oz. 2. ½ gill vinegar; 1 gill spirits of wine; 1 dr. linseed oil. 3. Naphtha, 1 lb.; shellac, 4 oz.; oxalic acid, ¼ oz. Let it stand till dissolved, then add 3 oz. linseed oil.

Furniture Paste. — 1. To keep wood light, scrape ¼ lb. beeswax into ½ pint of turpentine. By adding linseed oil the wood is darkened. 2. Dissolve 6 oz. pearlash in a quart of hot water, add ¼ lb. of white wax, and simmer for half an hour in a pipkin; take from off the fire, and when cool the wax will float, which should be taken off, and, with a little hot water, worked into a paste. 3. Beeswax, spirits of turpentine, and linseed oil, equal parts; melt and cool. 4. Beeswax, 4 oz.; turpentine, 10 oz.; alkanet root to colour; melt and strain. 5. Digest 2 drs. of alkanet root in 20 oz. of turpentine till the colour is imparted; add yellow wax in shavings, 4 oz.; place on a water bath and stir till the mixture is complete. 6. Beeswax, 1 lb.; linseed oil, 5 oz.; alkanet root, ½ oz.; melt, add 5 oz. of turpentine, strain and cool. 7. Beeswax, 4 oz. resin, 1 oz.; oil of turpentine, 2 oz.; Venetian red to colour. 8. 1 lb. of white wax; 1 oz. black resin; 1 oz. alkanet root; and 10 oz. linseed oil.

Furniture Cream. — 1. Yellow

wax, 4 oz.; yellow soap, 2 oz.; water, 50 oz.; boil, with constant stirring, and add boiled oil and oil of turpentine, each 5 oz. 2. Soft water, 1 gallon; soap, 4 oz.; white wax, in shavings, 1 lb. Boil together, and add 2 oz. of pearlash. To be diluted with water, laid on with a paint brush, and polished off with a hard brush or cloth. 3. Wax, 3 oz.; pearlash, 2 oz.; water, 6 oz. Heat together, and add 4 oz. of boiled oil and 5 oz. of spirits of turpentine.

WHITE FURNITURE CREAM.—Raw linseed oil, 6 oz.; white wine vinegar, 3 oz.; methylated spirit, 3 oz.; butter of antimony, ½ oz.; mix the linseed oil with the vinegar by degrees, and shake well so as to prevent separation; add the spirit and antimony, and mix thoroughly.

Furniture Oils.—1. Boiled linseed oil, 1 pint; yellow wax, 4 oz.; melt, and colour with alkanet root. 2. Acetic acid, 2 drs.; oil of lavender, ½ dr.; rectified spirit, 1 dr.; linseed oil, 4 oz. 3. Linseed oil, 1 pint; alkanet root, 2 oz.; heat, strain, and add lac varnish, 1 oz. 4. Linseed oil, 1 pint; rectified spirit, 2 oz.; butter of antimony, 4 oz.

OIL FOR DARKENING FURNITURE.—1 pint linseed oil; 1 oz. rose-pink; and 1 oz. of alkanet root, beaten up in a metal mortar; let the mixture stand for a day or two; then pour off the oil, which will be found of a rich colour. Or, mix 1 oz. of alkanet root with 4 oz. of shellac varnish, 2 oz. of turpentine, the same quantity of scraped beeswax, and a pint of linseed oil: this should stand a week.

Furniture Reviver.—Pale linseed oil, raw, 10 oz.; lac varnish and wood spirit, of each 5 oz. Mix well before using.

Polish for Turners' Work.—Dissolve 1 oz. of sandarach in ½ pint of spirits of wine; shave 1 oz. of beeswax, and dissolve it in a sufficient quantity of spirits of turpentine to make it into a paste, add the former mixture to it by degrees; then, with a woollen cloth, apply it to the work while it is in motion in the lathe, and polish it with a soft linen rag; it will appear as if highly varnished.

Cleaning and Polishing Mahogany.—Take 1 pint of the furniture oil, mix with it ½ pint of spirits of turpentine and ½ pint of vinegar; wet a woollen rag with the liquid and rub the wood the way of the grain, then polish with a piece of flannel and soft cloth.

Furniture Polish.—Melt three or four pieces of sandarach, each of the size of a walnut, add 1 pint of boiled oil, and boil together for 1 hour. While cooling add 1 dr. of Venice turpentine, and if too thick a little oil of turpentine also. Apply this all over the furniture, and after some hours rub it off; rub the furniture daily, without applying fresh varnish, except about once in two months. Water does not injure this polish, and any stain or scratch may be again covered, which cannot be done with French polish.

To Polish Wainscot.—Take as much beeswax as required, and placing it in a glazed earthen pan, add as much spirits of wine as will cover it, and let it dissolve without heat. Add either one ingredient as is required, to reduce it to the consistence of butter. When this mixture is well rubbed into the grain of the wood, and cleaned off with clean linen, it gives a good gloss to the work.

Polish for Carved Cabinet-work.—Dissolve 2 oz. of seed-lac, and 2 oz. of white resin, in 1 pint of spirits of wine. This varnish or polish must be laid on warm, and if the work can be warmed also, it will be so much the better; at any rate, moisture and dampness must be avoided. Used with a brush for standards or pillars of cabinet-work. The carved parts of cabinet-work are also polished thus: varnish the parts with the common wood varnish, and having dressed them off where necessary with emery paper, apply the polish used for the other parts of the work.

Copal Polish.—Melt with gentle heat finely-powdered gum copal, 4 parts, and gum camphor, 1 part, with ether to form a semi-fluid mass, and then digest with a sufficient quantity of alcohol.

Polishing in the Lathe.—Good work does not require much polishing, for the beauty of it depends more on being

executed with tools properly ground, set, and in good order; the work performed by such tools will have its surface much smoother, its mouldings and edges much better finished, and the whole nearly polished, requiring, of course, much less subsequent polishing than work turned with blunt tools. One of the most necessary things in polishing is cleanliness; therefore, previous to beginning, it is as well to clear the turning-lathe or work-bench of all shavings, dust, and so on, as also to examine all the powders, lacquers, linen, flannel, or brushes which may be required; to see that they are free from dust, grit, or any foreign matter. For further security, the polishing powders used are sometimes tied up in a piece of linen, and shaken as through a sieve, so that none but the finest particles can pass. Although, throughout the following methods, certain polishing powders are recommended for particular kinds of work, there are others applicable to the same purposes, the selection from which remains with the operator; observing this distinction, that when the work is rough and requires much polishing, the coarser powders are best; but the smoother the work, the less polishing it requires, and the finer powders are preferable.

Soft woods may be turned so smooth as to require no other polishing than that produced by holding against it a few fine turnings or shavings of the same wood whilst revolving, this being often sufficient to give it a finished appearance; but when the surface of the wood has been left rough, it must be rubbed smooth with polishing paper, constantly varying the position of the hand, otherwise it would occasion rings or grooves in the work. When the work has been polished with the lathe revolving in the usual way, it appears to be smooth; but the roughness is only laid down in one direction, and not entirely removed, which would prove to be the case by turning the lathe the contrary way, and applying the glass paper; on which account work is polished best in a pole-lathe, which turns backwards and forwards alternately, and therefore it is well to imitate that motion as nearly as possible.

Mahogany, *walnut*, and some other woods, of about the same degree of hardness, may be polished by either of the following methods:—Dissolve, by heat, so much beeswax, in spirits of turpentine, that the mixture when cold shall be of about the thickness of honey. This may be applied either to furniture or to work running in the lathe, by means of a piece of clean cloth, and as much as possible should then be rubbed off by means of a clean flannel or other cloth. Beeswax alone is often used; upon furniture it must be melted by means of a warm flat iron; but it may be applied to work in the lathe by holding the wax against it until a portion of it adheres; a piece of woollen cloth should then be held upon it, and the lathe turned very quickly, so as to melt the wax; the superfluous portion of which may be removed by means of a small piece of wood or blunt metal, when a light touch with a clean part of the cloth will give it a gloss. A very good polish may be given to mahogany by rubbing it over with linseed oil, and then holding against it a cloth dipped in fine brick-dust. Formerly nearly all the mahogany furniture made in England was polished in this way.

Hard Woods.—These, from their nature, are readily turned very smooth; fine glass paper will suffice to give them a very perfect surface; a little linseed oil may then be rubbed on, and a portion of the turnings of the wood to be polished may then be held against the article, whilst it turns rapidly round, which will, in general, give it a fine gloss. Sometimes a portion of shellac, or rather of seed-lac, varnish is applied upon a piece of cloth, in the way formerly described. The polish of all ornamental work wholly depends on the execution of the same, which should be done with tools properly sharpened; and then the work requires no other polishing but with a dry hand-brush, to clean it from shavings or dust, this trifling friction being sufficient to give the required lustre.

Ivory or *bone* admits of being turned very smooth, or, when filed, may afterwards be scraped, so as to present a good surface. They may be polished by rubbing them first with fine glass paper, and then with a piece of wet linen cloth dipped in powdered pumice-stone; this will give a very fine surface, and the final polish may be produced by washed chalk or fine whiting, applied by a piece of cloth wetted in soapsuds. Care must be taken in this, and in every instance where articles of different fineness are successively used, that previously to applying a finer, every particle of the coarser material be removed, and that the rags be clean and free from grittiness.

Ornamented work must be polished with the same materials as plain work, using brushes instead of linen, and rubbing as little as possible; otherwise, the more prominent parts will be injured. The polishing material should be washed off with clean water, and when dry may be rubbed with a clean brush.

Horn and *tortoiseshell* are so similar in their nature and texture that they may be classed together, as regards the general mode of working and polishing them. A very perfect surface is given by scraping; the scraper may be made of a razor-blade, the edge of which should be rubbed upon an oil-stone, holding the blade nearly upright, so as to form an edge like that of a currier's knife, and which, like it, may be sharpened by burnishing. Work, when properly scraped, is prepared for polishing. To effect this, it is first to be rubbed with a buff, made of woollen cloth, *perfectly free from grease;* the cloth may be fixed upon a stick, to be used by hand; but what the workmen call a *bob*, which is a wheel running in the lathe, and covered with the cloth, is much to be preferred, on account of the rapidity of the operation. The buff is to be covered either with powdered charcoal and water, or fine brick-dust and water; after the work has been made as smooth as possible with this, it is followed by another buff, or *bob*, on which washed chalk, or dry whiting, is rubbed; the comb or other article to be polished is moistened slightly with vinegar, and the buff and whiting will produce a fine gloss, which may be completed by rubbing it with the palm of the hand and a small portion of dry whiting, or rottenstone.

Pigments. INDIAN RED.—When pure this is a native mineral production, it is manufactured artificially by calcining sulphate of iron until the water of crystallization is expelled, then roast it with a fierce fire until acid vapours cease to arise; cool, wash the remainder with water until the water ceases to affect litmus paper, then dry. An inferior quality is made by calcining 11 parts common salt with 25 parts green sulphate of iron, wash well with water, dry, and powder the remainder. As thus prepared Indian red is the same as *jewellers' rouge* and *colcothar.* When used as a pigment it is frequently mixed with red ochre. It is a very permanent colour, can be made of different tints, and is especially useful in fresco and silicious painting. The finest Indian red or *crocus* usually undergoes a second calcination, in which it is exposed to a very intense heat.

LIGHT RED, made from yellow ochre by careful calcination. This colour mixes well with both oil and water, and gives a capital *flesh colour* when mixed with white.

RED CHALK.—A natural clay containing nearly $\frac{1}{5}$ protoxide and carbonate of iron.

RED-LEAD.—Prepared by placing ground and well-washed massicot in iron trays piled up on the hearth of a reverberatory furnace, in a heat of from 600° to 650° Fahr., stirring it occasionally until of the proper colour.

Massicot (Protoxide of Lead).—Genuine massicot is the strongest oxide of lead, and its colour is a dull orange yellow, but artists occasionally apply the term massicot to white-lead roasted until it turns yellow. In the preparation of minium the lead is calcined in a reverberatory furnace; this process gives a mixture of massicot and lead; these are separated by washing and trituration; the massicot being much lighter remains

suspended in the water; it is drawn off, and left to settle; the *deposit* which it then forms is collected and dried, and this is the true massicot. It may be employed with advantage in preparing the drying oils; it produces the same effect as litharge when very finely ground. It may be employed as a colour; its tint is not brilliant; but as it is a better drier than white-lead, it may be substituted for it in mixing with colours which dry with difficulty, as the lakes and the bituminous earths.

Minium.—A higher degree of oxidation transforms the massicot into minium. On a large scale minium is prepared by calcining massicot in reverberatory furnaces; it becomes first of a dark orange colour, then purple, but this last tint disappears on its cooling; when at this point, the doors of the furnaces are closed, but not hermetically, so as to allow of a little air entering. The massicot cools very slowly; and as it absorbs the oxygen of the air, it becomes of a strong orange colour and grows finer in proportion to the slowness of its cooling. If instead of massicot we calcine ceruse, a peculiar red, called "mineral orange," is obtained; it is a minium, but of a tint more pure and brilliant than any of its class.

To Test Red-lead.—There are few substances to be found which can be mixed with red-lead without injuring its brilliant colour. Nevertheless, it is often mixed with brick-dust or red ochre. For detecting brick-dust, heat the red-lead in an earthen crucible, and then dissolve it in diluted nitric acid. If brick-dust is present it remains undissolved. To detect red ochre, boil the red-lead in muriatic acid; dilute the solution with water and filter it. Add to a portion of the clear solution a solution of yellow prussiate of potash, and to another portion an excess of a solution of caustic potash. If the first reagent produces a dark blue precipitate, and the second a brown precipitate, the red-lead contains red ochre.

Vermilion.—Vermilion is a sulphide of mercury; it may be used in oil, water, fresco, and silicious painting. In all cases, however, it gets slightly darker in time; this is not a chemical but a physical change. With the exception mentioned, this pigment is very permanent. Vermilion is composed of mercury and sulphur, very intimately combined. It is found naturally formed in the quicksilver mines; but that which is used in painting is an artificial production. 1. Vermilion is prepared by melting one part of sulphur, and adding to it gradually five or six parts of mercury; the heat is continued until the mixture swells up, then cover the vessel and remove it from the heat; when the mixture is cold reduce it to powder and sublime in a closed vessel so placed in a furnace that the flames may play freely around it to about half its height. The heat is gradually increased until the lower portion of the subliming vessel becomes red hot; the cold sublimate is broken into pieces, ground in water to a fine powder, passed through a sieve and dried. At first the mixture becomes black, takes the name of Æthiops mineral, or black sulphuret of mercury; this substance is then reduced to powder, and sublimed in appropriate vessels, when a crystallized mass is obtained, composed of bright filaments of a violet tint; by trituration it becomes of a scarlet colour. But the mere grinding will not be sufficient to give a bright tone to the vermilion; various methods are employed for that purpose, which are not generally known. Some manufacturers grind these ingredients up with plain water or with urine, and afterwards boil it for some time; others treat it with nitric acid; but it does not happen that any of the methods hitherto employed for heightening the colour of vermilion obtained by sublimation, give the same brightness as the Chinese vermilion, the preparation of which is not known. 2. Quicksilver 300 parts, flowers of sulphur 114 parts, grind them together or some hours and then add gradually 75 parts caustic potash dissolved in 450 parts water; continue the grinding for some time longer, then gently heat the mixture in an iron vessel, first stirring constantly, but afterwards only at intervals, keeping the heat as near 115° Fahr. as

possible, and observing to add fresh water as the evaporation takes place. When the colour begins to redden great care is necessary to preserve the mixture at the proper temperature and to keep the sulphuret of mercury quite pulverulent. As soon as the colour is nearly fine the process must be conducted with increased caution and at a lower heat for some hours, until a rich colour is produced. This is well washed in water and dried. It is very injurious for those employed to inhale mercurial vapours, for which reason this operation should be performed only in a place where the chimney has a good current of air; there also should be fixed to the tube of glass with which the mixture is stirred a staff sufficiently long to hold at good distance from the vessel; in the same way the spoon should be lengthened with which the potash is added.

Carmine.—Boil 1 lb. of cochineal and 4 drs. carbonate of potassa in 7½ galls. of water for quarter of an hour. The pot is taken from the fire and 8 drs. alum in powder mixed into the liquor, which is afterwards well stirred and then allowed to settle for 20 minutes or so. The liquid is poured into a fresh vessel and a solution of 4 drs. fish glue or isinglass, dissolved in a pint of water and strained, mixed with it. When a skin is formed upon the surface the heat is taken away and the liquor rapidly stirred, and allowed afterwards to settle for half an hour or so, when the deposited carmine is carefully collected, drained, and dried.

Painters' Cream.—Pale nut-oil, 6 oz., mastic 1 oz.; dissolve; add ¼ oz. of sugar of lead ground in a little oil; then add water, gradually, until it acquires the consistence of cream, working it well all the time. Used by painters to cover their work when they are obliged to leave it for some time. It may be washed off with a sponge and water.

Lakes.—Lakes are made by adding a solution of alum, either alone or partly saturated with carbonate of potassa, to a filtered infusion or decoction of the colouring substance, and after agitation precipitating the mixture with a solution of carbonate of potash; by precipitating a decoction or infusion of the colouring substance made with a weak alkaline lye, by adding a solution of alum; or by agitating recently-precipitated alumina with a solution of the colouring matter, prepared as before, until the liquid is nearly decoloured, or the alumina acquires a sufficiently dark tint. The first method is usually employed for acidulous solutions of colouring matter, or for those whose tint is injured by alkalies; the second, for those that are brightened, or at least uninjured by alkalies; the third, for those colouring matters that have a great affinity for gelatinous alumina, and readily combine with it by mere agitation. By attention to these general rules, lakes may be prepared from almost all animal and vegetable colouring substances that yield their colour to water, many of which will be found to possess great beauty and permanence. The precise process adapted to each particular substance may be easily ascertained by taking a few drops of its infusion or decoction, and observing the effects of alkalies and acids on the colour. The quantity of alum or of alumina employed should be nearly sufficient to decolour the dye liquor, and the quantity of carbonate of potassa should be so proportioned to the alum as to exactly precipitate the alumina without leaving free or carbonated alkali in the liquid. The first portion of the precipitate has the deepest colour, and the shade gradually becomes paler as the operation proceeds. A beautiful tone of violet, red, and even purple may be communicated to the colouring matter of cochineal by the addition of perchloride of tin; the addition of arseniate of potassa in like manner gives shades which may be sought for in vain with alum or alumina. After the lake is precipitated, it must be carefully collected, washed with cold distilled water, or the purest rain water, until it ceases to give out colour, and then carefully dried in the shade. In this state it forms a soft velvety powder.

Drop Lake is made by dropping the moist lake through a small funnel on a clean board or slab, and drying it by a gentle heat. A very little clear gum-water is commonly added to the paste

to give the drops consistence when dry. Synonymous with *Brazil-wood Lake.*

BLUE LAKE.—A fugitive colour prepared from some of the blue-coloured flowers. The name is also applied to lump archil, to moist alumina coloured with indigo, and to mixed solution of pearlash and prussiate of potash, precipitated with another solution of sulphate of iron and alum. These are permanent and beautiful, but are seldom used, in consequence of indigo and Prussian blue supplying all that is wanted in this class of colours.

BRAZIL-WOOD LAKE.—1. Ground Brazil-wood, 1 lb.; water, 4 galls.; digest for 24 hours, then boil for half an hour, add alum, 1½ lb., dissolved in a little water; mix, decant, strain, and add a solution of tin, ½ lb.; again mix well and filter; to the clear liquid add, cautiously, a solution of salt of tartar or carbonate of soda, as long as a deep-coloured precipitate forms, carefully avoiding excess; collect, wash, and dry. The product is deep red. By collecting the precipitate in separate portions, lakes varying in richness and depth of colour may be obtained. The first portion of the precipitated lake has the brightest colour. An excess of alkali turns it violet, and the addition of cream of tartar, brownish red. The tint turns more on the violet red when the solution of tin is omitted. Some persons use less, others more, alum. 2. Add washed and recently-precipitated alumina to a strong and filtered decoction of Brazil-wood. Inferior to the last.

CARMINATED LAKE.—1. The residuum of the cochineal left in making carmine is boiled with repeated portions of water, until it is exhausted of colour; the resulting liquor is mixed with that decanted off the carmine, and at once filtered; some recently-precipitated alumina is then added, and the whole gently heated, and well agitated for a short time; as soon as the alumina has absorbed sufficient colour, the mixture is allowed to settle, after which the clear portion is decanted, the lake collected on a filter, washed, and dried. The decanted liquor if still coloured is now treated with fresh alumina until exhausted, and thus a lake of a second quality is obtained. 2. To the coloured liquor obtained from the carmine and cochineal as above, a solution of alum is added, the filtered liquor precipitated with a solution of carbonate of potassa, and the lake collected and treated as before. Scarcely so good as the last. Some makers mix a solution of tin with the coloured liquor, adding the alum or alumina; this brightens the colour. The above lake is a good glazing colour with oil, but has little body.

COCHINEAL LAKE.—1. 1 oz. cochineal in coarse powder; water and rectified spirit, of each, 2½ oz.; digest for a week, filter, and precipitate the tincture with a few drops of solution of tin, added every 2 hours, until the whole of the colouring matter is thrown down; lastly, wash the precipitate in distilled water, and dry it. 2. Digest powdered cochineal in ammonia water for a week, dilute the solution with a little water, and add the liquid to a solution of alum, as long as a precipitate falls, which is the lake. 3. Coarsely-powdered cochineal, 1 lb.; water, 2 galls.; boil 1 hour, decant, strain, add a solution of salt of tartar, 1 lb., and precipitate with a solution of alum. By adding the alum first, and precipitating the lake with the alkali, the colour will be slightly varied. All the above are sold as Carminated or Florence Lake, to which they are often superior.

GREEN LAKE.—Made by mixing blue and yellow lake together. Generally prepared extemporaneously by the artist on his palette.

LAC LAKE.—Boil fresh stick-lac in a solution of carbonate of soda, filter the solution, precipitate with a solution of alum, and proceed as before. A fine red.

MADDER LAKE.—1. Crop madder, 2 oz.; tie it in a cloth, beat it well in a pint of water in a stone mortar, and repeat the process with about 5 pints of fresh water until it ceases to yield colour; boil the mixed liquor in an earthen vessel, pour it into a large basin, and add 1 oz. of alum, previously dissolved in a pint of boiling water; stir well, and while stirring, pour in gradually of a

strong solution of carbonate of potassa or oil of tartar, $1\frac{1}{2}$ oz.; let the whole stand until cold, then pour off the yellow liquor from the top, drain, agitate the residuum with boiling water in separate quantities, 1 quart; decant, drain, and dry. Product, $\frac{1}{2}$ an oz. The Society of Arts voted their gold medal to the author of this formula. 2. Add a little solution of acetate of lead to a decoction of madder, to throw down the brown colouring matter, filter, add a solution of tin or alum, precipitate with a solution of carbonate of soda or of potassa; proceed as before. 3. Ground madder, 2 lbs.; water, 1 gall.; macerate with agitation for 10 minutes, strain off the water, and press the remainder quite dry; repeat the process a second and third time; then add to the mixed liquors, alum, $\frac{1}{2}$ lb. dissolved in water, 3 quarts; and heat in a water bath for 3 or 4 hours, adding water as it evaporates; next filter, first through flannel, and when sufficiently cold, through paper; then add a solution of carbonate of potassa as long as a precipitate falls, which must be washed until the water comes off colourless, and, lastly dried. If the alkali be added in 3 successive doses, 3 different lakes will be obtained, successively diminishing in beauty.

ORANGE LAKE.—Spanish annatto, 4 oz.; pearlash, $\frac{3}{4}$ lb.; water, 1 gall.; boil for half an hour, strain, precipitate with alum, 1 lb., dissolve in water, 1 gall., observing not to add the latter solution when it ceases to produce an effervescence or a precipitate; strain, and dry the sediment in small squares, lozenges, or drops. The addition of some solution of tin turns this lake on the lemon yellow; acids redden it.

RED LAKE.—Pearlash, 1 lb.; clean shreds of scarlet cloth, $3\frac{1}{2}$ lbs.; water 5 galls.; boil till the cloth is decoloured, filter the decoction, and precipitate with a solution of alum, as before. See *Madder Lake.*

YELLOW LAKE.—1. Boil French berries, quercitron bark or turmeric, 1 lb., and salt of tartar, 1 oz., in water, 1 gall., until reduced to one-half; then strain the decoction, and precipitate with a solution of alum. 2. Boil 1 lb. of the dye-stuff with alum, $\frac{1}{2}$ lb.; water, 1 gall.; as before, and precipitate the decoction with a solution of carbonate of potash. See Orange Lake.

White Pigments.—ALUM WHITE.—Powdered Roman alum, 2 lbs.; honey, 1 lb.; mix dry, powder, calcine in a shallow dish to whiteness, cool, wash, and dry. A beautiful and permanent white, both in oil and water.

DERBYSHIRE WHITE.—From chalk or heavy spar, by grinding and elutriation.

MINERAL WHITE.—Precipitated carbonate of lead.

NEWCASTLE WHITE. — White-lead made with molasses vinegar.

NOTTINGHAM WHITE. — White-lead made with alegar. Permanent white is now commonly sold for it.

PEARL WHITE.—Fard's Spanish white. Trisnitrate of bismuth.

PERMANENT WHITE.—Artificial sulphate of baryta, prepared by precipitating chloride of barium with dilute sulphuric acid, or a solution of glauber salts. A good fast white unchanged by sulphurous fumes. Used to mark jars and bottles for containing acids or alkalies, as it is affected by very few substances; also to adulterate white-lead.

SPANISH WHITE. — The softest and purest white chalk, elutriated, made into balls, and well dried. Used as a cheap white paint.

WHITE-LEAD.—Made by suspending rolls of thin sheet lead over malt vinegar, or pyroligneous acid, in close vessels, the evaporation from the acid being kept up by the vessels being placed in a heap of dung, or a steam bath. Commercial carbonate of lead, however prepared, is not the pure carbonate of lead, but always contains a certain proportion of hydrate. It is generally largely adulterated with native sulphate of baryta or heavy spar, and sometimes with chalk. The former may be detected by its insolubility in dilute sulphuric acid, or a solution of oxalic acid or oxalate of ammonia, after having been treated with sulphuretted hydrogen, or a hydrosulphuret, to throw down the lead. Pure carbonate of lead does not lose weight at a temperature of

212° Fahr.; 68 grains are entirely dissolved in 150 minims of acetic acid diluted with 1 fl. oz. of distilled water; and the solution is not entirely precipitated by a solution of 60 grains of phosphate of soda. The solution in nitric acid should not yield a precipitate when treated with a solution of sulphate of soda. Used as a superior white paint, and, in medicine, as an external astringent refrigerant, and desiccant. The particles of carbonate of lead prepared by precipitation, or by any of the quick processes, are in a somewhat crystalline and semi-translucent condition, and hence do not cover so well as that just noticed; also called fine white, and flake white. The following are some of the varieties of white-lead found in commerce.

DUTCH WHITE-LEAD.—1. From flake white, 1 cwt.; chalk, 3 cwt. 2. (Ordinary.) Flake white, 1 cwt.; chalk, 7 cwt. These form the best white-lead in the shops.

2. ENGLISH WHITE-LEAD. — Flake white lowered with chalk; covers badly, and the colour is inferior to the preceding.

FRENCH WHITE-LEAD. — From litharge dissolved in vinegar and the lead thrown down by a current of carbonic acid gas from coke. Does not cover so well as flake white.

HAMBURG WHITE.—From flake white, 1 cwt; chalk, 2 cwt. Also sold for best Dutch white-lead.

VENETIAN WHITE.—From flake white, or pure white-lead and chalk, equal parts.

SULPHATE OF LEAD.—From an acetic or nitric solution of litharge precipitated by adding dilute sulphuric acid, and the white powder washed and dried. The clear liquid decanted from the precipitate is poured on fresh litharge, when a second solution takes place; this may be repeated for any number of times.

CHINESE WHITE.—Take as much as is required of zinc white finely ground, put it on a marble or glass slab, mix it into a cream of the required consistence by adding mucilage of gum tragacanth, grinding with a glass muller. For quantity required to fill an ordinary sized Chinese white bottle, add to above 10 or 12 drops of thick mucilage of gum arabic and 5 or 6 drops of pure glycerine; grind well together, and fill bottle by aid of palette knife. Make tragacanth mucilage by putting a small piece, size of a horse bean, into 2 oz. of cold water, letting it remain a day or two till gum swells up and absorbs water, then beat into a pulp. It will easily regrind when dry with a little fresh medium. As required consistence depends much on habit and practice, we do not specify any exact proportions. It is easy to add white or medium to suit taste. The cost when thus made is very trifling.

WHITING. — The same as prepared chalk, but prepared more carelessly, in horse-mills.

WILKINSON'S WHITE.—From litharge ground with sea water until it ceases to whiten, and then washed and dried.

Green Pigments. — BARTH'S GREEN. — Yellow lake, Prussian blue, and clay, ground together.

BREMEN GREEN.—This is properly green verditer, but other preparations are frequently sold under the name.

BRIGHTON GREEN.—Sulphate of copper, 7 lbs., add sugar of lead, 3 lbs.; each separately dissolved in water, 5 pints; mix the solutions, stir in whiting, 24 lbs., set the paste on chalk stones, and when dry grind it to powder.

BRUNSWICK GREEN.—A saturated solution of sal ammoniac, 3 parts, is poured over copper filings or shreds, 2 parts, contained in a vessel capable of being closed up, and the mixture is kept in a warm place for some weeks, when the newly-formed green pigment is separated from the unoxidized copper, by washing the mixture on a sieve; it is then washed with water, and slowly dried in the shade. Colour very deep and rich. The lighter shades are produced by the addition of sulphate of baryta. In another method a solution of crude carbonate of ammonia or bone spirit is added to a mixed solution of alum and blue vitriol, as long as it affects the liquor; in a short time the precipitate is collected, washed, and dried. The various shades of green are produced by using different quantities of alum, which "pales" and "cheapens" it.

CHROME GREEN.—Prepared by melting in a crucible equivalent quantities of anhydrous boracic acid and bichromate of potassium, and treating the fused mass with water. The hydrated oxide thus produced is washed and finely triturated. Common chrome green is a mixture of chrome yellow and Prussian blue.

EMERALD GREEN.—A pulp is formed with verdigris, 1 part, and sufficient boiling water, and after being passed through a sieve, to remove lumps, is added gradually to a boiling solution of arsenious acid, 1 part, in water, 10 parts, the mixture being constantly stirred until the precipitate becomes a heavy granular powder, when it is collected on a calico filter, and dried on chalk stones.

GELLART'S GREEN.—A mixture of cobalt blue and flowers of zinc with some yellow pigment.

IRIS GREEN.—A pigment prepared by grinding the juice of the petals of the blue flag with quicklime. It is very fugitive.

MOUNTAIN GREEN.—Native green carbonate or bicarbonate of copper ground to powder, either with or without the addition of a little orpiment or chrome yellow. That of the shops is commonly prepared by adding a solution of carbonate of soda, or of potassa, to a hot mixed solution of sulphate of copper and alum. Green verditer is commonly sold for this article.

PRUSSIAN GREEN.—The sediment of the process of making Prussian blue from bullock's blood or horns, before it has had the hydrochloric acid added to it. It is also prepared by pouring liquid chlorine upon freshly-precipitated Prussian blue. As sold, this pigment is generally a mixture of Prussian blue and gamboge.

SAP GREEN.—A very fugitive pigment, prepared from the juice of buckthorn berries. The berries are allowed to ferment for a week or eight days in a wooden tub. The juice is then pressed out, strained, a little alum added, and the whole evaporated to a proper consistence; it is next run into pigs' bladders, and hung up in a dry situation to harden. An inferior article is made from the juice of black alder, and of evergreen privet. It is a common practice to add ¾ pint of lime water and ½ oz. of gum arabic to every pint of either of the above juices. Powdered arsenious acid, 11 oz.; carbonate of potassa, 1½ lb.; boiling water, 1 gall.; dissolve, filter, and add the solution, as before, to another solution of crystallized sulphate of copper, 2 lbs., in water, 3 gall. Product, 1½ lb. A very fine grass-green colour.

SCHEELE'S GREEN.—White arsenic in powder, 1 part; commercial potash, 2 parts; boiling water, 35 parts; dissolve, filter, and add the solution gradually, whilst still warm, to a filtered solution of sulphate of copper, 2 parts, as long as a precipitate falls; wash the newly-formed pigment with warm water, and dry it.

VIENNA or SCHWEINFURT GREEN.—Arsenious acid, 8 lbs., is dissolved in the least possible quantity of boiling water, and added to verdigris, 9 or 10 lbs., diffused through water, at 120° Fahr., the pap of the latter being first passed through a sieve; the mixed ingredients are then set aside till the mutual reaction produces the proper shade. 2. Sulphate of copper, 50 lbs., and lime, 10 lbs., are dissolved in good vinegar, 20 gall., and a boiling-hot solution of white arsenic, 50 lbs., is conveyed as quickly as possible into the liquor; the mixture is stirred several times, and then allowed to subside, after which it is collected on a filter, dried, and powdered. The supernatant liquor is employed the next time for dissolving the arsenic.

MANGANESE GREEN.—Prepared by mixing intimately 3 or 4 parts caustic barytes, moistened with water, 2 parts nitrate of barytes, and 2 of oxide of manganese; then introducing the mixture into a crucible heated to dull redness, and when it has fused, pouring it out, pulverizing it, digesting it in boiling water washing it with cold water, and drying it in an atmosphere which contains no carbonic acid. It answers well for paper hangings, being applied by means of thin glue, and for some other purposes, white of egg being used instead of the glue.

Yellow Pigments.—CHROME YELLOW.—1. Add a filtered solution of nitrate or acetate of lead to a like solu-

tion of neutral chromate of potash, as long as a precipitate falls; then collect this, wash it well with clean soft water, and dry it out of the reach of sulphuretted vapours. 2. Dissolve acetate of lead in warm water, and add a sufficient quantity of sulphuric acid to convert it into sulphate of lead; decant the clear liquid, wash the residuum with soft water, and digest it with agitation in a hot solution of yellow neutral chromate of potash, containing 1 part of that salt to every 3 parts of sulphate of lead; decant the liquid, which is a solution of sulphate of potash, and carefully drain, wash, and dry the newly-formed pigment. The product contains much sulphate of lead, but covers as well, and has as good a colour as pure chromate of lead, whilst it is much cheaper. The shade may be varied by increasing or lessening the quantity of the chromate.

KING'S YELLOW, or ORPIMENT. — A native sulphuret of arsenic. It is prepared artificially by sublimation from a mixture of arsenious acid and sulphur; or by collecting the precipitate when a stream of sulphuretted hydrogen gas is passed through a solution of arsenious acid.

NAPLES YELLOW.—1. Powdered metallic antimony, 3 parts by weight, oxide of zinc 1, red-lead 2, mixed, calcined, ground to a fine powder and fused in a closed crucible; the fused mass is ground to a fine powder and well washed. 2. Washed diaphoretic antimony 1 part, red-lead 2, grind with water to a stiff paste, and expose in a crucible to a red heat for 4 or 5 hours.

Blue Pigments.—ULTRAMARINE.—Pure lapis lazuli reduced to fragments about the size of a pea, and the colourless pieces rejected; 1 lb. is heated to redness, quenched in water, and ground to an impalpable powder; to this is added, yellow resin, 6 oz.; turpentine, beeswax, and linseed oil, each, 2 oz., previously melted together; the whole is next made into a mass, which is kneaded in successive portions of warm water, as long as it colours it blue; from these it is deposited on repose, and is then collected, well washed with clean water, dried, and sorted according to its qualities. The first water, which is usually dirty, is thrown away; the second gives a blue of the first quality; and the third and following ones yield samples of less value. Ultramarine is the most costly, but at the same time the most splendid and permanent, of our blue pigments, and works well in oil.

ULTRAMARINE ASHES.—Obtained from the resinous mass from making ultramarine, by melting it with fresh oil, and kneading it in water containing a little potash or soda; or, by burning away the wax and oil of the mass and well grinding and washing the residue with water. Very permanent, but much less brilliant than ultramarine.

AZURE BLUE, or PARIS BLUE.—1. Sulphur, 2 parts; dry carbonate of soda, 1 part; mix well; gradually heat them in a covered crucible to redness, or till the mixture fuses, then sprinkle in, by degrees another mixture of silicate of soda and aluminate of soda (containing 72 parts of silica and 70 parts of alumina), and continue the heat for an hour. The product contains a little free sulphur, which may be separated by water. 2. Kaolin, 37 parts; sulphate of soda, 15; carbonate of soda, 22; sulphur, 18; charcoal, 8; intimately mixed and heated from 24 to 30 hours, in large crucibles; the product is then heated again in cast-iron boxes, at a moderate temperature, till the required tint is obtained; it is finally pulverized, washed, and dried. 3. Take crystallized carbonate of soda, 1075 grs.; apply a gentle heat, and, when fused in its water of crystallization, shake in finely-pulverized orpiment, 5 grs., and, when partly decomposed, add as much gelatinous hydrate of alumina as contains 7 grs. of anhydrous alumina; finely-sifted clay, 100 grs., and flowers of sulphur, 221 grs., are next to be added; the whole placed in a covered crucible, and at first gently heated, to drive off the water; but as soon as this is effected, raised to redness, the heat being so regulated that the ingredients only "sinter" together, without actually fusing; the mass is then to be cooled, finely pulverized, suspended in river water, and brought upon a filter;

the product has now a very beautiful delicate green or bluish colour, but on being heated in a covered dish, and stirred about from time to time, until the temperature reaches that of dull redness, at which it must be kept for one or two hours, it changes to a rich blue. If the heat of the first calcination has been properly regulated, the whole of the mass taken from the crucible will have uniform colour; but if too little heat has been used, and the ingredients have not been properly mixed, there will be colourless parts, which should be rejected; if too much heat has been used, or the mass allowed to fuse, brown parts will appear, especially if the crucible is of a bad kind, or easily destroyed; these must also be rejected.

Cobalt Blue.—Prepared by slowly drying and heating to dull redness a mixture of freshly-precipitated alumina freed from water as much as possible, 8 to 10 parts; arseniate or phosphate of cobalt, 1 part. By daylight it is of a pure blue, but by artificial light the colour turns on the violet.

Prussian Blue.—Mix alum, 2 parts, with sulphate of iron 1 part, add water sufficient to dissolve. Then make a solution of yellow prussiate of potash, add to it a little sulphuric acid, and when mixed drop in the first solution until the precipitate falls slowly; wash well on a filter and dry. Or add a solution of protosulphate of iron to one of red prussiate of potash; wash and dry.

Saxon Blue.—Dissolve in 1 gallon of water 1 oz. sulphate of iron and 8 oz. alum; add together separate solutions of prussiate of potash and ordinary pearlash, until the mixture ceases to deposit a precipitate. After the deposit has stood for some time it should be collected, washed thoroughly, and dried.

Black Pigments.—Ivory Black.—Take any quantity of ivory-turner's waste or ivory dust, place in a closed crucible and expose for a sufficient time to strong heat. Cool the crucible, remove and powder its contents, wash in warm water and dry. An inferior pigment termed Bone Black is made by treating bones in a similar manner.

Lampblack.—Cooley's 'Cyclopædia' has the following receipts for the preparation of this useful pigment. 1. A conical funnel of tin-plate furnished with a small pipe to convey the fumes from the apartment, is suspended over a lamp fed with oil, tallow, coal-tar, or crude naphtha, the wick being large and so arranged as to burn with a full smoky flame. Large spongy, mushroom-like concretions of an exceedingly light, very black, carbonaceous matter gradually form at the summit of the cone, and must be collected from time to time. The funnel should be united to the smoke-pipe by means of wire, and no solder should be used for the joints of either. 2. On a large scale, lampblack is made by burning bone-oil, previously freed from its ammonia, or common coal-tar, and receiving the smoke in a suitable chamber. In one process the coal-tar is violently agitated with lime water until the two are well mixed, after which it is allowed to subside, and the lime water having been drawn off, the tar is washed several times with hot water. After subsidence and decantation, it is put into stills, and rectified. The crude naphtha in the receiver is then put into a long cast-iron tube furnished with numerous large burners, underneath which is a furnace to heat the pipe to nearly the boiling point. Over each burner is a sort of funnel which goes into a cast-iron pipe or main, which thus receives the smoke from all the burners. From this main the smoke is conveyed by large pipes to a succession of boxes or chambers, and thence into a series of large canvas bags arranged side by side, and connected together at top and bottom alternately. Fifty to eighty of these bags are employed; the last one being left open to admit of the escape of the smoke, which has thus been made to traverse a space of about 400 yards. As soon as the bags contain any considerable quantity of black, they are removed and emptied. The black deposited in the last bag is the finest and best, and it becomes progressively coarser as it approaches the furnace. The state of minute division in which the carbon exists in good

lampblack is such as cannot be given to any other matter, not even by grinding it on porphyry, or by elutriation or washing over with water. On this account it goes a great way in every kind of painting. It may be rendered drier and less oily by gentle calcination in close vessels, when it is called Burnt Lampblack, and may then be used as a water colour; or its greasiness may be removed by being passed through water slightly alkalized with potassa.

Russian Lampblack is the soot produced by burning the chips of resinous deal. It is objectionable chiefly from being liable to take fire spontaneously when left for some time moistened with oil.

Blue Black.—Vine-twigs dried and then carefully carbonized, in covered vessels, until of the proper shade. Pit-coal, carefully burnt at a white heat, then quenched in water, dried, and well ground, forms a cheap, good, and durable blue black, fit for most ordinary purposes.

Ochres.—These substances are hydrates of iron mixed in various proportions, and sometimes closely combined with various sorts of earth. The greater the proportion of clay, the brighter will be the colour: when there is a portion of clay, the substance feels greasy to the touch, and has more body than those have which are mixed with chalk and silex. The yellow ochres become red by calcination: the brown ochres, when pure, produce the finest red. Ochres may be prepared artificially, by moistening the rust of iron, and precipitating, by the alkalies, solutions of this metal. For instance, in precipitating it by the sub-carbonate of soda, or of muriate of potass, of nitrate, of acetate of iron, or persulphate of iron, the most brilliant brown ochres are obtained. If the sulphate of iron is of a low oxidization, the precipitate is olive-coloured, but it soon becomes yellow at the surface by absorbing a greater quantity of oxygen. To extend this operation to all the precipitates, it only requires exposure to the air, by stirring it up for a sufficient time. The same thing may be obtained in winter quite easily, by exposing it to the action of frost in wide shallow pans: the water passing into the state of ice leaves a small quantity of air disengaged, which unites with the precipitate, and is sufficient to give it an even yellow tone. When bright ochres are required, it will be necessary to mix alum, in certain proportion, with sulphate of iron; the solution is then to be precipitated by lime water. There exist in the natural state ochres of so very fine a quality, that they require no other preparation than that of being washed; therefore it is scarcely worth while to manufacture them artificially.

Cake Colours.—Procure a small slab and muller of glass, and grind the powders into a smooth stiff paste with equal parts of isinglass size and thin gum water; compress into squares as closely as possible, and dry with a very gentle heat. Old crumbling cake-colours may be powdered very finely in a biscuit-ware mortar, sifted through fine muslin, and ground up as above, omitting the gum water in the medium. If the powders are rubbed up with honey to the consistence of thick cream, they answer admirably as moist colours.

Jay's Metallic Paint.—Break common resin into dust or small pieces, and then dissolve in benzoline or turpentine until the solution acquires the consistency of syrup or treacle, or equal parts of each of the above spirits or hydrocarbons, and any other hydrocarbon that will dry and combine with drying oils, can be used instead of turpentine or benzoline. When the solution is complete it is gradually added to oxide of zinc, which has previously been made into a paste with boiled linseed oil, until the whole mixture acquires the consistency of paint suitable for use. A white paint is thus produced of a durable and glossy character. Other pigments, such as sulphate of barytes, oxide of iron, Brunswick green, or red-lead, can be added to make any desired colour of paint. One great advantage of its use, says the inventor, is its effectual resistance to heat and moisture. It never blisters or cracks, even under the hottest sun or the most inclement weather.

Paint for Wirework.—Boil good linseed oil with as much litharge as will make it of the consistency to be laid on with the brush; add lampblack at the rate of 1 part to every 10 by weight of the litharge; boil three hours over a gentle fire. The first coat should be thinner than the following coats.

Economical Paint.—Skim milk, 2 quarts; fresh-slaked lime, 8 oz.; linseed oil, 6 oz.; white Burgundy pitch, 2 oz.; Spanish white, 3 lbs. The lime to be slaked in water, exposed to the air, mixed in one-fourth of the milk; the oil in which the pitch is previously dissolved, to be added a little at a time; then the rest of the milk, and afterwards the Spanish white. This quantity is sufficient for 27 square yards, two coats.

Anti-corrosive Paint.—Take equal parts by weight of whiting and white-lead with half the quantity of fine sand, gravel, or road-dust, and a sufficient quantity of colouring matter. This mixture is made in water and can be used as a water colour; but it is more durable to dry it in cakes or powder after mixing, and then use it as an oil-paint by grinding it again in linseed oil. The preparation of oil recommended for this purpose is 12 parts by weight of linseed oil, 1 boiled linseed oil, and 3 sulphate of lime, well mixed. One gallon of this prepared oil is used to 7 lbs. of the powder.

Bronze Paint (*for Iron* or *Brass*).—Chrome green, 2 lbs.; ivory black, 1 oz.; chrome yellow, 1 oz.; good japan, 1 gill; grind all together and mix with linseed oil.

Painting in Oil Colours.—The implements and materials necessary for oil painting are: oil, varnish, colours, brushes, a palette, a palette knife, an easel, a rest stick, canvas, and a little chalk or crayon.

PALETTES.—Palettes are made of mahogany, and of satin and other light-coloured woods also; those made of the latter are preferable, because the colours and mixed tints are best seen upon them. They should be light in weight, and thin, and so perforated as to rest well-balanced on the thumb. Palettes are made of oval and oblong shapes; the latter form is more generally useful and convenient, as affording a greater space for the working of tints, as well as for their advantageous arrangement. Wooden palettes should be prepared for use by rubbing into them as much raw linseed oil as they can be made to imbibe. If this dressing with oil be thoroughly effected, and the palette be then suffered to dry till it becomes hard, the wood will subsequently not be stained by the absorption of colour. A palette thus prepared is easily cleaned, and presents a hard and polished surface, exceedingly agreeable for the preparation of tints. It is important to keep the palette free from indentations and scratches, and on no account to neglect cleaning it; the colour never being allowed to harden upon the wood.

The Easel.—The easel is a frame which supports the painting during its progress. Easels are of various forms; but the most convenient is undoubtedly the rack-easel, which allows the painter to raise or lower his work with speed and convenience, as occasion may require. The commoner and cheaper kinds are supplied with pegs for this adjustment of the height of the work. It is desirable that the easel should stand firmly, and not be liable, as is too often the case, to be overset by any slight cause.

The Rest, or *Mahl Stick.*—This is used to rest or guide the right hand or arm when particular steadiness is required, as is the case in the painting of small objects and minute details. It is usually formed of cane or of lance-wood, and it should be light, yet firm. The lower end of the stick is held in the left hand, while the upper extremity, which is covered with a soft round ball or pad of leather, to prevent injury, rests on the canvas or some other convenient support.

Brushes for Oil Painting.—To paint with effect it is of the first consequence to have the brushes well selected, and of the best quality that can be procured. They are of various kinds:—of hog-hair, sable, badger, fitch, and goat-hair. Of these, the most useful are the hog-hair, sable, and badger brushes. The black fitch and white goat-hair are but seldom

used, as the sable and hog tool will effect all that can be done by the former. Nothing can be superior to a well-made, fine, white bristle tool, in larger work; or to a good red sable for details.

Hog-hair Tools.—These brushes are made both round and flat. Flat hog-hair are generally more useful than round ones; they are preferred, as assisting in giving a squareness and crispness of touch. They should be strongly and neatly made; and in selecting them be sure that the hair has not been cut at the points, for this is sometimes done with inferior brushes; but such brushes have an unpleasant and coarse touch, laying on the colour in a scratchy manner. It will be found to be a good test, if they be made of a very fine silky-looking hair, and be very soft to the touch. They should however be firm, yet elastic; springing back to their form after being pressed laterally upon the hand. Lastly, their shape should be flat and wedge-like, without straggling or diverging hairs. Let the handle be of cedar, and polished; the cedar is pleasant and light to hold, and being polished is easily cleaned. The old white pine handles, sooner becoming ingrained with colour, are both dirty and disagreeable to work with.

Sable Brushes.—The observations regarding hog-hair tools will apply to the sable tools; but these latter should have the additional property of coming to a fine, yet firm point. Be careful in choosing sable brushes, the hair of which is of a pale yellowish cast; and see that the brush is firm, and that it springs well to its point. The round sable tool is as serviceable as the flat one, and is used in working the finishing parts of a painting. Round brushes in quills, known by the name of sable pencils, are also applicable to the same purpose. Pencils that bag or swell where the hair is inserted in the quill, or the hairs of which diverge and form several points, are worthless.

Badger Tools are of various sizes; and the hair, instead of coming to a close end or point, as in other brushes, diverges or spreads out, after the manner of a dusting brush. When good, the hair is long, light, and pliant, of a reddish brown or black, with clean white ends. The chief use of the badger tool is to soften or sweeten broad tints, such as skies, water, distances, and the like; it is a very valuable assistant to the young painter; but must be used with caution, because its injudicious use frequently destroys forms, and produces woolliness. If the badger tool be much employed on a large surface of colour, the points of the hair frequently become so loaded with colour, that it is necessary to clean it often. This is best done by pinching up the brush rather tightly at the ends, and wiping it on a clean rag. The brush is thus kept free from colour during the progress of the work, which might otherwise be sullied and deteriorated in the purity of its tones. The badger brush is also useful to the landscape painter, for carrying minute points of colour into those wet parts of the work which require to be lightened, enriched, or varied.

Cleaning Oil-paint Brushes. — All brushes, after being used, should be carefully cleaned. This is best effected by immersing the hair of the brushes in a little raw linseed oil; the oil should afterwards be washed out with soap and warm water, till the froth which is made by rubbing the brushes on the palm of the hand is perfectly colourless. The brushes should next be rinsed in clean water, and the water pressed out by a clean towel. The hair should then be laid straight and smooth, and each brush restored to its proper shape, by passing it between the finger and thumb, before it is left to dry. Care should be taken not to break the hair by too violent rubbing, as that would render the brushes useless. Many painters use turpentine instead of linseed oil, in the cleaning of brushes, it effects the object more quickly, but the only use of turpentine that should be permitted, is to rinse the brushes in it slightly, when it is required to clean them quickly; but on no account should they be permitted to remain soaking in the turpentine, as this practice is certain to injure the brushes; rendering the hair harsh and intractable, and frequently dissolving the cement by

which the hair is held in the socket of the handle.

Canvas.—This is the general material used for painting. It is kept prepared in rolls of various widths, and is sold also strained on frames of any required size. The ground or preparation of the canvas should be thin, yet completely covering the threads of the fabric; and it should be free from projecting lines and knots.

Oil Sketching Paper is an extremely serviceable material for the young artist. It is made of drawing paper, covered with two or three thin coats of oil colour, so as to furnish a ground similar to that of prepared canvas. It is cheap and portable, and serves very well for early attempts and for preparatory sketches; for trying the effects of any work previous to its commencement, as well as during its progress. The paper has this advantage, that, if the sketch is required to be preserved, it can readily be pasted or glued upon the canvas, and then mounted on a deal frame, when it will present the appearance of strained canvas.

Grounds.—Much diversity of opinion has existed respecting the colour of the surface of the prepared canvas. It is a subject of considerable importance, for it is impossible to paint a richly-coloured picture, with life and warmth, upon a dull unsuitable ground. A landscape, if carefully handled, can be brought on and finished in a more brilliant manner on a white ground than on any other. It has however been objected to a purely white ground, that it is liable to impart a cold chalky effect; but it must be remembered that what is at first white in oil, becomes in a short time of a yellowish hue, and its coldness of tone is thereby lowered. The white, or pale cream-coloured, and pale, warm, drab-coloured grounds, seem to surpass all others. The reason is that they throw a light, and consequently a transparency, through the work; and, as all colours in oil painting have a tendency to sink into the ground on which they are laid, and to become darker, this tendency can be counteracted only by having grounds of considerable lightness and brilliancy. Cold grey grounds have been used in landscape painting; but they impart a heaviness of colouring much to be avoided. Some artists have painted on grounds of a dull red, or leather-coloured tint, and much richness may be gained by such tints; but after a time the colours of any portion that may have been thinly painted sink into this strong ground, and the effect produced is heavy and disagreeable. Upon the whole, a white ground is to be preferred, as soon as the learner has acquired some experience of the subsequent effect of his colours; but as the inexperienced find much difficulty in preventing the coldness and poverty of expression which it is likely to cause under their hands, it will be advisable for the beginner to take the usual light stone drab that is generally given to canvas; for it furnishes him with a middle tint or tone to start from, which, when visible in shadows and middle tints, has not the raw chalkiness shown under similar circumstances on an unskilfully or imperfectly covered white ground.

VEHICLES are used to temper and thin the colours, for the purpose of bringing them to a proper working state. All oils or varnishes act more or less to the eventual prejudice of the colour with which they are combined for application. What is desired in oil painting is a vehicle which, while it has an agreeable working quality, shall neither change nor be degraded by time, nor interfere with the purity of the tints as they appear at the moment they are first laid on;—a vehicle, that shall neither perish nor crack as it becomes old.

Oils.—The linseed, poppy, and nut oils are the fixed oils used as vehicles; turpentine and occasionally spike-lavender are the essential oils so used. Of the fixed oils, linseed is in most common use. It should be of a pale amber colour, transparent, and limpid; and, when used in moderately warm weather, it should dry in a day. The most valuable qualities of linseed oil, as a vehicle, consist in its great strength and flexibility. It is by far the strongest oil, and the one which dries best and firmest

under proper management. The next in importance is poppy oil. It is inferior in strength, tenacity, and drying, to linseed oil; but it has the reputation of keeping its colour better than linseed oil; and it is on this account generally employed in grinding white, and most of the light pigments. Nut oil is more uncertain in its qualities than either linseed or poppy oil; and is frequently extremely long in drying. Poppy oil, however, supplies its place so well, that it is not commonly required. Oils are all more or less influenced in their drying by the colours with which they are combined; some of which greatly accelerate, while others retard it. With certain colours some oils will scarcely dry at all, unless means are employed to cause them to do so.

Japanners' Gold Size is sometimes employed as a powerful means of drying dark and transparent colours, which are in general comparatively bad dryers.

Megilps.—The vehicles known by this name are in great favour with artists. They possess a gelatinous texture, which enables them, while flowing freely from the pencil, yet to keep their place in painting and glazing. The megilp generally in use is formed by mixing together equal parts of strong mastic varnish and drying oil. After remaining undisturbed for a few minutes, it assumes a gelatinous texture, resembling a thin, transparent, amber-coloured jelly. Megilp varies in colour, as it is made with either a pale or deep-coloured drying oil. The palest is made by using instead linseed oil, in which a small quantity of finely-ground sugar of lead has been diffused. With equal parts of this compound, and of mastic varnish, a very light megilp is obtained. Another megilp is made by mixing 1 part of a saturated solution of sugar of lead in water, with 2 parts of linseed or poppy oil. These are to be well stirred or shaken together, till they are combined; and then 2 parts of mastic varnish added, and well mixed with the preceding. By this means a white creamy emulsion is obtained, which, though opaque in use, becomes quite transparent as it dries. A compound used occasionally in combination with megilp, and consisting of 1 part of copal varnish, 1 part of linseed or poppy oil, and 1 part of turpentine, will furnish a pleasant and serviceable vehicle for general use. Care must be taken, however, to force its drying by the addition of ground sugar of lead, when employed with slowly-drying pigments.

Glazing.—A glaze is a thin transparent film of colour, laid upon another colour to modify the tone, or to aid the effect of the latter; the work thereby appearing distinctly through the superimposed layer of glaze, from which it receives a characteristic hue. Glazing is effected by diluting proper transparent colours with megilp or other suitable vehicle. Thus diluted, these colours are laid upon portions of the work, either in broad flat tints, or in touches partially and judiciously distributed. The object of this process is to strengthen shadows, and to give warmth or coldness to their hue; to subdue lights that are unduly obtrusive, or to give additional colour and tone to those that are deficient in force and richness. Should it be necessary to lighten the tone of any part of the picture, this cannot be done by merely glazing; the first tints must first be concealed with brighter colours, of sufficient body for that purpose, and the glaze may then be applied. The glaze should usually be darker than the ground colour upon which it is to be laid; and, as a rule, it may be observed that the first painting of the picture should be brighter than the subject may require, in order that the subsequent glazings may lower and obscure it to a proper and effective degree of tone. Glazing is generally effected by the application of diluted transparent colours; but occasionally semi-transparent colours are used for this purpose, provided they are rendered sufficiently transparent by the admixture of a large proportion of vehicle. These latter glazings are capable of being applied with excellent effect, where it may be necessary to modify the tones of those parts of the

picture which do not appear satisfactory, or to produce particular effects, such as representations of smoke, dust, mists, and the like. Caution is, however, necessary in glazing with opaque colours; because, if used in excess, they will deteriorate the picture, by destroying its transparency. Should a glazing produce a result different from what was intended, the glaze may easily be removed by a rag, or, if the spot be small, by the finger, provided the removal be effected *immediately*, that is, before the glaze has had time to fasten itself upon, or to soften, the colour on which it is laid, and in no case must glazing be attempted before the colours over which it is laid have become perfectly dry and firm.

IMPASTING.—In oil painting, the shadows, or dark portions of the picture, are painted thinly, while the lights are laid on, or impasted with a full pencil and a stiff colour. In the lights of the foreground, and of parts not intended to be remote, or to retire, the impasting should be bold and free; while, in the more brilliant lights, it cannot well be too solid. There is, however, a reasonable limit to the practice; since actual protuberance or prominence of the paint itself will, in certain lights, produce a false shadow, and therefore a bad and false effect. This will be understood, from observing that the loading of thick masses of colour upon the picture, so as to make them project considerably from the surface, is done with the view of their being strongly illuminated by light actually incident upon the picture, and of thus mechanically aiding in the production of roundness and relief, or in giving a sparkling effect to polished objects or glittering points. But this artifice must be had recourse to sparingly and cautiously; else it defeats its own object, and produces a coarse and vulgar air and effect. The palette knife has always been a favourite instrument of this impasting, or laying on of colour, capable as it is of producing an agreeable brightness on, and of giving an appropriate flatness to, the pigment. A clear and appropriate tint, for instance, skilfully swept across a sky by these means, often produces a surprisingly brilliant and charming effect.

SCUMBLING.—Scumbling, the opposite process to that of glazing, is done by going lightly over the work with an opaque tint, generally produced by an admixture of white. For this purpose a hog-hair brush is employed, charged with colour but sparingly; and with it the tints are drawn very thinly, and somewhat loosely, over the previous painting, which should, as in the case of *glazing*, be dry and firm. Scumbling is used to modify certain effects, by rendering the portion, to which it is applied, cooler, greyer, and in fact less defined, than it was before, and to give air and distance to objects that seemed too near. It is thus of service both in correcting a tendency to muddiness or dirtiness of colour, and to what may be called hardness or over-distinctness of detail, and in weakening the force of colours that are too powerful by softening and uniting such tints as may be too violently contrasted. It is desirable to avoid, as far as possible, scumbling over shadows, as an inexperienced hand might thus destroy their transparency.

Harmony of Colours.—Harmony of colour is produced by an equable use and distribution of the primary colours, whether used simply as such, or united in various proportions in their compounds. Harmony is recognized in a picture when nothing exists in it that disturbs the eye by violent opposition or contrast of colours; judicious contrast, however, tends much to produce harmony, when the force of the contrast is diminished by the *juxtaposition of tones partaking more or less of the colours employed in producing the contrast.* This we shall find is the process employed by nature, the reds in which are harmonized with the contrasting green by hues of orange, or yellow green; and so with other colours. Harmony of colour in painting is best obtained by setting the palette with those pigments which, through the prevalence of any of the primaries, blend, or, as it were, run into

each other. Thus, commencing with white, we proceed to yellow, orange, or yellow-reds, red, blue-reds, blues, green-blues, greens, browns, grey, and black. A palette can be set warm or cold, as the subject may require, by selecting pigments in which blue predominates or is deficient.

Primaries.	BLUE is contrasted by ..	Red and Yellow,	or Orange.	Secondaries.
	RED is contrasted by ..	Blue and Yellow,	or Green.	
	YELLOW is contrasted by ..	Blue and Red,	or Purple.	
Secondaries.	Orange, or	Red and Yellow,	is contrasted by BLUE.	Primaries.
	Green, or	Blue and Yellow,	is contrasted by RED.	
	Purple, or	Blue and Red,	is contrasted by YELLOW.	

Painting in Water Colours.—

The practice of the art consists of sketching the outline, of tinting or shading with sepia, bistre, or india-ink; and of the application of the pigments, in three or more successive stages, to the attainment of a finished drawing. Our instructions must, of necessity, be of a general character, because almost every artist of genius finds out for himself and practises some peculiar methods of applying the pigments, which can only be learned by those who become his pupils. These peculiar methods constitute the various styles of the masters of the art, by which their works are so readily recognized and distinguished.

Materials. — The principal materials required by the painter in water colours are drawing paper, ivory, for miniatures, a drawing board, pigments or colours, lead pencils, hair pencils, or brushes, palettes, slabs, and saucers, cups or glasses for holding water, sponge, gum water, ox-gall, india-rubber, drawing pins, a sharp convex-pointed knife, a flat ruler.

The Painting Room.—The choice of a situation for the practice of painting is not a matter of indifference: the room should be well lighted, of a northern aspect, if possible, and free from reflected colours from opposite objects. As dust and grease are inimical to the delicacy and integrity of water-colour painting, it will be the first care of the student to guard against them. The light should fall on the left hand of the painter, and not be admitted below the head. A room lighted from above, or by a skylight, is much to be preferred.

Pencils, or Brushes for Water Colours.—The hair pencils, or brushes used in water-colour painting are made of camel-hair, and fitch, or sable. The best are those known as soft brown or black sables; those made of red sable are not so useful, as they possess the bad quality of stiffness, and disturb the colours by their harshness. These brushes will hold a considerable quantity of fluid, and should be used full, but not to overflowing, so as to become unmanageable. After using, they should be carefully washed in clean water, and then slightly pressed in a piece of clean linen rag. A brush put away unwashed, especially if it has been used for india-ink, or any dark pigment, can scarcely ever be cleaned again so as to be fit to use with light or delicate pigments. For large drawings brushes are prepared, both round and flat, mounted in tin; these are also useful in washing. The most essential quality of a good pencil is, that it should yield a good point, for it is that part only which is used; the hairs when moistened should form a cone terminating in a fine and delicate point. It should also be firm, yet elastic, returning to a straight direction immediately upon being lifted from the paper.

Management of a Water-Colour Drawing.—The manipulation in water-colour painting is of the greatest simplicity, consisting merely in selecting the pigments required, mixing from them the various tints the subject demands, and leaving them in their proper places upon the paper. These pigments are rubbed with boiled or distilled water, on earthenware slabs, with the addition of a small quantity of gum water, for the strong marking of the shadows, and so on. It is the usual practice to lay on the first tints or washes with the hard-cake pigments ground on the slabs, while the middle or foreground is painted with the soft, or body-colours; which, by remaining constantly moist, are always ready for use.

The pigments should be ground in sufficient quantity, and with so much water as to be quite fluid, and capable of entirely filling the brush; the superfluous quantity can be easily removed by slightly pressing the brush on the edge of the palette; for unless the pigments are reduced to this state of fluidity, the drawing acquires a dry and harsh appearance; while, at the same time, an excess of fluidity produces a thinness and meagreness, leaving a dark edge surrounding the coloured surface, which inevitably betrays the inexperienced hand. The progress of a water-colour drawing is from simply washing with the requisite colours, as a preparatory stage, and proceeding by gradual and delicate additions where they are required, and so on to the finishing, which consists in applying the colours in their full body and strength, giving solidity to the forms, and a definiteness to the outlines that constitutes a finished picture, equal in vigour, freshness, and richness of tone to oil painting. Many parts of the drawing must unavoidably be gone over with colour that should be left white for the high or brilliant lights: the colour must be removed from these places by rubbing with a sharp scraper or by moistening the spot to be reclaimed with a pencil dipped in clean water; after it has remained a few moments, the moisture is removed with a piece of clean blotting paper, and then rubbing the surface of the paper by means of a white handkerchief, india-rubber, or bread-crumbs.

House Painting. — To produce the different tints, various colours are added to the white-lead base, in quantity according to the intensity of the tint desired, amounting, sometimes, to an exclusion of the white-lead in the upper or finishing coats. The following are the colours generally used by the house painter:—

White. — White-lead, Nottingham white, flake white.

Black.—Ivory black, lampblack, blue black, patent black.

Yellows.—Chrome yellow, King's yellow, Naples yellow, yellow ochre, raw sienna, yellow lake.

Browns.—Burnt umber, raw umber, Vandyke brown, purple brown, Spanish brown, York brown.

Reds.—Vermilion, scarlet lake, crimson lake, Indian red, Venetian red, red-lead, orange-lead, burnt ochre, burnt sienna.

Greens.—Brunswick green, emerald green, verdigris.

Blues.—Prussian blue, indigo, cobalt, ultramarine.

To bring these colours to a state fit for use, they are ground up with a small quantity of oil; but for painting in distemper, the colours must be ground up in water. Linseed oil is that which is in general use, and is quite sufficient for the purpose of the plain painter, especially when improved by being kept for several years, as it then loses a great part of its colour. In rare instances, where the least yellowness in the oil would be injurious, nut or poppy oil may be used with advantage. Spirit of turpentine is largely employed in painting; it is obtained by distillation from crude turpentine, which is procured from the larch and fir trees: being of a volatile nature, it is used by the painter to produce what is called a flat; it evaporates, and leaves the paint without the least shine. It is also employed in those situations where oil would not dry, as in the first coat on old work, which is likely to be a little greasy from smoke.

Driers.—To hasten the drying of paints, driers are generally used. Those most in use are sugar of lead, litharge, and white copperas. These, when well ground and mixed in small portions with paint, very much assist them in drying; indeed, some colours will not dry without them. Red-lead is also an excellent drier; and in cases where its colour is not objectionable, is much used. Sugar of lead is, however, the best drier, though somewhat more expensive than the others. It should be observed that, in the finishing coats of delicate colours, driers are generally avoided, as they have a slight tendency to injure the colour. Linseed oil has sometimes a drying quality given to it by boiling with drying substances, which renders it extremely

useful on some occasions. A very good drying oil is made by boiling 1 gallon of linseed oil with a ½ lb. of litharge, or red-lead, reduced to a fine powder. It must be kept slightly boiling for about 2 hours, or until it ceases to throw up any scum; when cold, the clear oil must be poured off, and kept for use.

HOUSE PAINTERS' TOOLS.—The brushes used are of all sizes, both round and flat, and are made chiefly of hog-hair. The large round brush called the pound brush, and a smaller one called the tool, are those mostly used in plain work. The smallest hog-hair brushes are called fitches, and are used for putting in small work where the tool would be too large. The pound brush is used as a duster for some time previous to putting it in colour, and thus it is rendered much softer. The smallest brushes are the camel-hair pencils with long or short hair, according to the work to be done. The stopping knife has a shorter blade than the palette knife, and is pointed. It is used for making good the holes and cracks with putty. Putty is made of common whiting, pounded fine, and well kneaded with linseed oil, till it becomes about the consistence of stiff dough.

GRINDING COLOURS FOR HOUSE PAINTING.—When a colour-mill is not used, the grindstone and muller is an apparatus necessary to every painter, as the purity of the colours sold ready ground at the shops is not to be depended upon; and some colours, as lakes and Prussian blue, will not keep long after grinding. The grindstone is a slab of porphyry marble, or granite, about two feet square; the chief requisite is, that it be hard, and close-grained. The muller is a hard and conical-formed stone, the diameter of the base or rubbing surface of which should be about one-sixth of that of the grindstone, and the cone high enough to get a sufficient hold of it with the hands. The face of both grindstone and muller should be perfectly flat and smooth. A large palette knife is used to gather the colour from the stone as soon as it is sufficiently ground. All substances employed for painting in oil require to be ground up with a small portion of the oil, previous to mixing them with the whole quantity required for use; for this purpose, they must first be pounded, and passed through a tolerably fine sieve, then mixed with a portion of linseed oil, just sufficient to saturate them; a quantity, about the size of a small egg, is to be taken on the point of the palette knife, and placed on the stone; the muller is then placed upon it, and moved round about, or to and fro in all directions, bearing a little weight on it at the same time. This should be continued until it is ground perfectly fine, having the consistence and smoothness of butter. The colour must be occasionally trimmed from the edges of the stone and muller with the palette knife, and put under the muller in the middle of the stone. When sufficiently ground, it is removed from the stone with the palette knife, and a fresh quantity taken. It is not well to have much colour on the stone at one time; it makes it more laborious, and will take a longer time to grind the same quantity equally well.

MIXING COLOURS FOR HOUSE PAINTING.—Before the colours which have been ground can be applied to the work, they must be rendered fluid by the addition of linseed oil, or spirits of turpentine, or certain proportions of both. When a tinted colour is required to be mixed up, a small quantity of the proper tint should be first prepared on the palette, which will serve as a guide to mix the whole quantity by. With the ground white-lead there should first be well mixed a portion of oil, and then the tinting colour should be added, as ascertained by the pattern on the palette. When these are thoroughly mixed and matched to the proper tint, the remaining portion of the oil or turpentine is to be added; this is better than putting in all the oil at once: it should then be strained through a piece of fine canvas, or fine sieve, and should be about the consistence of cream, or just so as to work easily. If it is too thick, the work will have an uneven, cloudy appearance, and it will be hard to spread; while, if it be too thin, it will be likely to run, or will require a greater

number of coats to cover the ground, and render the work solid. The straining ought not to be neglected where the appearance of the work is studied.

Painting New Work. — Clean the work, carefully removing all projections, such as glue, or whiting spots; this is easily done with the stopping knife and duster; then cover over the knots with a composition of red-lead, called knotting. If the knots are very bad, they must be cut out. After knotting comes the priming, or first coat of paint. When the priming is quite dry, all nail-holes, cracks, and defects, are to be made good with putty; then proceed to the next coat, called the second colour; when this is dry, those places are to be stopped which were omitted in the last coat: and proceed according to the number of coats intended to be given. It should be observed that second colour for new work is made up chiefly with oil, as it best stops the suction of the wood; but second colour for old work is made up chiefly with turpentine, because oil colour would not dry or adhere to it so well. The colour should be spread on as evenly as possible; and to effect this, as soon as the whole, or a convenient quantity, is covered, the brush should be passed over it in a direction contrary to that in which it is finally to be laid off; this is called crossing. After crossing, it should be laid off softly and carefully, in a direction contrary to the crossing, but with the grain of the wood, taking care that none of the crossed brush marks be left visible. The criterion of good workmanship is, that the paint be laid evenly, and the brush marks be not observed. In laying off, the brush should be laid into that portion of the work already done, that the joining may not be perceived. Every coat should be perfectly dry, and all dust carefully removed, before the succeeding one is laid over it.

Painting Old Work.—Carefully remove all dirt and extraneous matter with the stopping knife and duster; those places near the eye should be rubbed with pumice-stone, and greasy places should be well rubbed with turpentine. Bring forward new patches and decayed parts with a coat of priming; stop and make good with putty, then proceed with the first coat, or second colour, in turpentine. The quality of the next coat will depend upon the manner in which it is to be finished. If it is to be painted twice in oil, and flatted, the next coat, or third colour, should be mixed up chiefly in oil, and tinted like the finishing colour, to form a ground for the flatting. The greater the shine of the ground, the more dead will be the finishing coat or flatting: likewise, the more dead the ground, the better will the finishing oil shine; therefore, it is a general rule that for finishing in oil the under coat should be turpentine, and for finishing flat, the under coat, or ground colour, should be oil; but observe, that all turpentine under-coats have a little oil with them, and all oil under-coats, except the priming or first coat on new work, have a little turpentine with them. Knotting is made with red-lead, carefully ground, and thinned with boiled oil and a little turpentine. For inside work, red-lead carefully ground in water, and mixed up with double size, is a good substitute, and is generally used: it must be used hot.

Priming for New Work.—This is made of white-lead, with driers and a little red-lead to harden it, and further to assist its drying; it is thinned entirely with oil, and should be made very thin, as the new wood, or plaster, sucks it in very fast. It is a frequent practice with painters to save the oil coats by giving the new work a coat of size, or size and water, with a little whiting, called clearcole; but where durability is consulted, this should not be done. The size stops the suction of the wood or plaster, but at the same time it prevents the oil paint from adhering to the work; the consequence is, that it is apt to peel or chip off, especially in damp places. Clearcole is sometimes advantageously used on old greasy work on which oil paint would not dry.

Second Colour for New Work, or oil

second colour. — This is white-lead thinned with oil and a little turpentine, with suitable driers. The proportion of driers for ordinary cases is about $1\frac{1}{2}$ oz. to 10 lbs. of white-lead; but in winter, or under other unfavourable circumstances, the quantity of driers must be increased.

Second Colour for Old Work, or turpentine second colour. — This is white-lead thinned with about 3 parts of turpentine, and 1 of oil, also a little driers. Where much turpentine is used, less driers are required.

Turpentine Colour.—This is only used when the work is to be finished in oil; that is left shining. It is thinned almost entirely with turpentine, that the finishing coat may have a better gloss.

Third, or Ground Colour, is thinned with two-thirds oil and one-third turpentine, and tinted a shade darker than the finishing colour.

Finishing Oil Colour is thinned with a little more oil than turpentine, and tinted to the desired colour.

Flatting, or finishing turpentine colour, is thinned entirely with turpentine, and has no shine.

Bastard Flat is thinned with turpentine and a little oil, which renders it more durable than the perfect flatting. To procure a good flat, it is necessary to have a perfectly even glossy ground, and it should be of the same tint, but a little darker than the finishing flat.

Clearcole and Finish. — Stop defects with putty, clearcole, and finish with oil finishing colour, as directed.

Two Coats in Oil.—Turpentine second colour, and finishing oil colour.

Two Coats in Oil and Flat.—Turpentine second colour; third colour; and flat.

Three Coats in Oil. — Turpentine second colour; turpentine colour; and finishing oil colour.

Three Coats in Oil and Flat (old work). —Turpentine second colour; turpentine colour; third, or ground colour; and flatting.

Four Coats in Oil (new work).—Oil priming; oil second colour; turpentine colour; and oil finishing colour.

Four Coats in Oil and Flat (new work). —Oil priming; oil second colour; turpentine colour; third or ground colour; and flatting.

Colours for House Painting. — *Stone Colour.*—White-lead, with a little burnt or raw umber, and yellow ochre.

Grey Stone Colour.—White-lead, and a little black.

Drab.—White-lead, with burnt umber and a little yellow ochre for a warm tint, and with raw umber, and a little black for a green tint.

Pearl Colour, or pearl grey.—White-lead with black, and a little Prussian blue.

Sky Blue.—White-lead, with Prussian blue.

French Grey. — White-lead, with Prussian blue, and a little lake. These last, used in various proportions, will make purples and lilacs of all shades.

Fawn Colour.—White-lead, with stone ochre, and a little vermilion or burnt stone ochre.

Buff.—White-lead and yellow ochre.

Cream Colour. — Same as the last, with more white.

Lemon Colour. — White-lead, with chrome yellow.

Orange Colour. — Orange-lead, or chrome yellow and vermilion.

Peach Colour.—White-lead, with either vermilion, Indian red, purple brown, or burnt stone ochre.

Gold Colour.—Chrome yellow, with a little vermilion and white.

Violet Colour. — White-lead, with vermilion, blue and black.

Sage Green. — Prussian blue, raw umber, and yellow stone ochre, with a little white, and thinned with boiled oil and a little turpentine.

Olive Green. — Raw umber, with Prussian blue, thinned as before.

Pea Green.—White-lead, with Brunswick green, or with Prussian blue and chrome yellow.

Chocolate Colour.—Spanish brown, or Venetian red and black, thinned with boiled oil and a little turpentine.

Lead Colour.—White-lead and black.

Plain Opaque Oak Colour.—White-lead, with yellow ochre and burnt umber.

Plain Opaque Mahogany Colour. — Purple brown, or Venetian red, with a little black.

Black should be ground in boiled oil, and thinned with boiled oil and a little turpentine. It will be obvious that the proportions of the colours above mentioned must be determined by the particular tone of colour required.

Cleaning House Paint.—Old paint work should be first well dusted, then cleaned by washing with a ley of pearlash and water; it is sometimes necessary, after the washing, to give a coat of weak size, and as soon as it is dry, apply varnish, using copal for light work, and carriage for dark. Some hand-rails, doors, and so on, are so saturated with grease, that no washing will remove it. When this is the case, brush the foul parts over with strong fresh-made lime-wash, let that dry, then rub it off; if the grease is not removed, repeat the lime-washing, until the grease is thoroughly drawn out; wash the lime clean off, and afterwards apply the sizing, and lastly the varnish.

To Paint Plaster.—Five coats are generally requisite to paint plaster well; but where it is not of a very absorbent nature, four are found to answer. The first is composed of white-lead, diluted with linseed oil, to rather a thin consistency, in order that the plaster may be well saturated; and into this is put a small quantity of litharge to ensure its drying. In painting quick plaster, the oil in this coat is entirely absorbed, thus hardening it to the extent of about the eighth of an inch inwards from the surface. When this is found to be the case, the second coat should also be thin, that the plaster may be thoroughly saturated; and it will be found necessary after this to give other three coats, making in all five. The second coat will be found to be but partially absorbed, and it is therefore requisite to make the third coat a good deal thicker, and to introduce into it a little spirits of turpentine, and such of the colouring pigments already enumerated, as may bring it somewhat near to the tint of which the apartment is to be finished. The fourth coat should be as thick as it can be well used, and should be diluted with equal parts of oil and spirits of turpentine. The colour of it ought to be several shades darker than that which is intended for the finishing coat, and the dry ingredient, sugar of lead instead of litharge. These coats ought all to be laid on with much care, both as to smoothness and equality, and each lightly rubbed with sand paper before the application of the other. The finishing or flatting coat, as it is termed from its drying without any gloss, is next applied. It ought, like others, to be composed of pure white-lead, ground as already described, and diluted entirely with spirits of turpentine; and it should appear, when mixed, a few shades lighter than the pattern chosen for the wall, as it darkens in the drying. The drying ingredient should be a small portion of japanners' gold size. This coat must be applied with great care and dispatch, as the spirits of turpentine evaporate very rapidly, and if touched with the brush after that takes place, which is in little more than a minute after its application, an indelible glossy mark will be left on the surface. Nothing has been said of the time that each of the coats will take to dry sufficiently to receive the next, as that depends much upon the state of the weather, the quantity of driers employed, and the atmosphere kept up in the apartment. It may be observed, however, that under any circumstances the first coat ought to stand a few days before the application of the second; the second a little longer before the application of the third; and the third, unless in four-coat work, should have still longer time to harden. But the coat immediately before the flatting or finishing coat ought not to stand above two days, as much of the beauty and solidity of the work will depend on the latter dying into, and uniting with the former.

Fresco Painting.—The preparation of a wall for fresco painting is a matter of time and should proceed with much carefulness, for on the goodness of this portion of the work depends in a great measure the durability of the painting. If the wall is already covered

with plaster or laths it should be cleared, the bricks thoroughly scraped, and afterwards well chipped. See that the bricks are in good condition and perfectly dry, and then proceed to lay on the first coat, consisting of river sand and the best old lime, mixed to about the usual thickness. This should be laid on so as to leave a level but rough surface. At some places on the Continent small flint pebbles are mixed with this composition to give the requisite roughness. This ground-work should be allowed to dry thoroughly; indeed, unless the lime is old, it will be some considerable time before it will be safe to put on the intonaco or painting-surface. This should be prepared with the very best old lime, perfectly free from grit. The lime is mixed in troughs to the consistence of milk, and is then passed through hair sieves into jars, where it is allowed to settle, and the water poured off. It is then ready to be mixed with the sand (fine quartz sand, well sifted, is the best) in the proportion of one part lime to two parts sand. The implements used to float on the last coat are made of wood or glass, but trowels of iron may be used if free from rust, and care is taken not to press the iron too forcibly on the intonaco. When the lime and sand coating is ready to be laid, the rough cast must be wetted thoroughly, and the intonaco floated on in two coats, the last with rather more sand than the first. The thickness of the two should be about $\frac{3}{16}$ths of an inch. After these are spread, go over the whole with a roll of wet linen, which will remove the marks of the trowel, and prevent the surface being too smooth. While the ground is being prepared a cartoon or drawing on paper is made of the subject, executed with a correct outline and with the wished-for effect properly shown. When the finished cartoon is made the same size as the painting it is usually executed in black and white with ink or crayons, but it is also necessary to have a study of the subject in colours, and this is generally done on a small scale. The pigments used are mostly minerals, and are ground and applied with pure water. With the surface of the wall still wet but firm and smooth, the tracing is laid over the portion prepared, and the lines of the cartoon slightly indented on the plaster with a blunt point; or the lines have small holes in them pierced at certain intervals and the design thus pricked out, laid upon the ground and dusted with a pounce-bag containing fine dry powder, and thus the outline is repeated on the ground by the dots of powder which have passed through the minute holes. When the intonaco has become firm enough to just bear the pressure of the finger the first washes of colour may be put on. If the painting is intended to be large, only sufficient plaster is put on to serve for the part which can be accomplished in the time at the disposal of the painter, usually enough only for a day's work, and this portion should end at the edges of some bold outline, as flowing drapery, a pillar, and so on. A difficulty in fresco painting is that the colours become much lighter after the plaster dries, and for this allowance must be made; however by practice the painter may overcome this difficulty, and can test the difference between the colour as wet and as dry by putting a touch upon a piece of umber, which instantly dries the colour and shows it as it will be when the intonaco has dried.

Transparent Painting on Linen.—The colours used in transparent painting are mixed with megilp as a vehicle, except in the case of very light colours, when turpentine and copal varnish must be used. The material upon which transparencies are executed is fine muslin; and this, before being worked upon, should be strained in a straining frame, and sized with either gilder's size, isinglass size, or fine colourless gelatine dissolved and properly diluted. After the first coat of size is dry the muslin will slacken and hang loosely on the frame. It should be stretched; another coat of size applied; and when dry the muslin again extended. A small piece of muslin should at the same time be prepared as a trial-piece, strained in the same way as the larger piece, and when dry it can be

used to determine whether the muslin is sufficiently sized, or whether the colours are in working condition. The design having been prepared, it may be traced, copied, pounced or stencilled upon the prepared muslin, care being taken that the outline from which the tracing is made consists of strong and decided lines, that stencil plates are made of oiled paper, and that powdered charcoal is used in preference to any other powder for pouncing. The instructions for *oil painting* will apply equally to painting transparencies, except that for very fine tints sponge can be used with great advantage to rub in broad flat tints, however delicate. Fine effects may be produced by the use of two transparencies, arranged one behind the other. On the front surface is painted all that is required to be seen in the clearest relief, the painting on the surface behind being modified in its effect by being seen through the front surface.

Transparent Painting on Paper.—The same colours as those of landscape painting are used for transparencies, and the processes are also the same: only it is requisite to be very attentive in washing in the tints with the utmost possible correctness, both with respect to form and to the power of colour, as the surface of the paper must be preserved clear in every part, and this clearness is always more or less injured by washing out or sponging. The paper should be the thinnest hard-wove drawing paper that can be procured, carefully selected, and free from unevenness or inequality of texture. When the paper has been selected according to the size of the proposed subject, it should be laid on a drawing board and fastened there, with a piece of thick paper beneath, in order that the tints may be distinctly seen during the painting. After having completed the subject so far as relates to the front, it may be cut off, leaving a margin of ¼ inch in breadth, for the purpose of gluing it down in the following manner. Take a sheet of Bristol-board, or, if the subject is larger, a thicker material, for the purpose of preserving the surface of the whole even and flat. From the centre of this board let a piece be cut out corresponding with the size of the painting, which must be placed on a drawing board, with its face downwards. Let it then be covered for a few minutes with a damp cloth, to cause it to expand a little; and in the meanwhile cover, with thick gum or glue, the edges of the aperture in the board, to correspond with the width of the margin cut off with the painting. The damp cloth may now be removed, and the painting turned with its face upwards, placing the board upon it accurately, in such a manner that the margin may adhere securely to the gum or glue in every part. The whole may then be laid on a flat surface to dry. In this way the Bristol-board will form a frame of such width as may be adapted to the painting, and this frame may be afterwards ornamented according to the taste or fancy of the student. It may be observed that the brilliancy of a transparent painting will be increased by the opacity of the border by which it is surrounded, and its width should be regulated by the size of the painting. As soon as the whole is thoroughly dry, the painting must receive such additions at the back as may be requisite to bring it up to the full luminous effect intended. For this purpose, the most convenient position will be one inclined in a sloping direction, similar to an artist's easel, and immediately in front of a steady light. When the painting has been placed in this position, it will immediately be perceived, that however strongly it may have been previously tinted or touched in the front, a strong light will cause it to appear comparatively feeble. But as the original intention of the workman will still be impressed on his mind, this weakness in the effect, which only becomes apparent by transmitted light, will suggest the addition of tints to produce the intended power. Where more is required, it must be cautiously applied at the back of the painting, taking all possible care to preserve the colours clear, and not to injure or ruffle the

texture of the paper, repeating the tints till the due power is obtained. When considerable power is required, such colours of Indian red, Cologne earth, or vermilion, must be selected as have a semi-opaque body; but care must be taken not to lay them on so thickly as to produce blackness. When richness is required, lake, Prussian blue, and gamboge, which are perfectly transparent, are well adapted to communicate not only richness but delicacy and power to finish. When, by carefully employing the means just pointed out, all possible harmony and effect have been imparted to the painting, it may be rendered partially or wholly luminous, by judiciously applying mastic spirit varnish. With a camel-hair pencil moderately charged with this varnish, let such parts as are in the highest lights be carefully touched as well as the major part of the sky, and the principal objects of the piece together with whatever part may require it in accordance with the character of the scene. If the whole of the subject is covered, it will be requisite to spread the varnish with a flat camel-hair brush, passing it quickly from side to side, and from top to bottom, so that the varnish may be equally spread with all possible expedition. The picture must then be left to dry. After the varnish has become dry, by mixing a little ox-gall in the water used for the colours, additional beauty of tint, as well as harmony, may be imparted to such parts as appear crude or harsh.

Painting and Preserving Ironwork.—A good black paint for coarse ironwork may be made by mixing plumbago with hot coal-tar. Equal parts of asphaltum and resin dissolved in common turpentine make also a good, cheap covering for heavy ironwork. For machinery, dissolve 2 lbs. india-rubber, 4 lbs. resin, and 2 lbs. shellac, in 5 galls. of benzine. This may be used with any other paint as a vehicle. Wrought-iron bridges are painted with white-lead as follows: The ironwork is first made clean by scrubbing and brushing it with wire brushes; this done, all the cavities and fissures are filled up with a putty of litharge, linseed oil, varnish, and white-lead; this filling being dry, brushing is repeated. Afterwards a paint is applied, consisting of 300 lbs. of white-lead, 10 galls. of crude linseed oil, 1 or 2 galls. of boiled linseed oil, and $1\frac{1}{4}$ gall. of turpentine. This paint is repeated when sufficiently dry, and finally evenly overspread with white sand. Galvanizing is employed also to prevent rusting. A galvanizing paint consists chiefly of zinc powder and oil varnish. Rusting is further prevented by rubbing the red-hot iron with wax, tallow, pitch, or coal-tar. Rubbing with heavy petroleum is also well adapted for keeping ironwork clean.

Painting Sign Boards.—Sign or pattern boards ought to be chosen of old well-seasoned wood; oak or mahogany is much the best, but many are made of pine, which ought to be sound, straight, close-grained, well-dried, and made with pieces let in across the back, to prevent warping. Thus prepared, brush the board over back and front with equal quantities of raw linseed oil, japanners' gold size, and turpentine, to which add a little ground white-lead; driving or rubbing out the colour well: for the second coat, take equal quantities of white-lead, common spruce ochre, and whiting, all well dried, and ground fine and stiff, separately with raw oil; mix the whole together; add sufficient of gold size to cause it to dry quickly, firm, and hard; dilute with turpentine to a proper consistence, and apply two or three coats of the above colour. When dry and hard, rub it smooth with either sand-paper or pumice-stone and water; then grind equal portions of spruce ochre, whiting, bath-brick, and white-lead, with two parts oil and one part turpentine, adding a little gold size, diluted with turpentine, and apply one, two, or three coats, if necessary, taking care to rub down and wash off the panel between each coat, repeating rubbing and colouring until the panel is as smooth and level as plate glass; it is then fit to receive the required last coat, to write, marble, paint, or grain upon. The finishing application, whether it be a plain ground,

landscape, figure, or letters, ought to stand until thoroughly dry and hard; it should finally be varnished twice over with best body copal or amber varnish, as the delicacy of the painting will admit.

To Prepare Picture Canvas.—Take suitable new canvas, stretch it well upon a stretching frame, wet it well with clean water, and afterwards dry it thoroughly; then stretch it a second time. Grind equal quantities of white-lead and whiting, well dried, with five parts of raw oil, and add one part boiled oil; prime the cloth over on the face with a brush, palette knife, or trowel; the latter is preferable, to those who can use it. After the canvas has had sufficient time to dry, scrape off from the back any superabundant colour which may have passed through the canvas; then repeat a second coat on the face, leaving it as smooth as possible. When hard and dry, rub it smooth with a piece of light pumice-stone and water, so as to cut off or lay all the knots in the canvas; then grind two parts white-lead, two parts whiting, and one part burnt ochre, with a small quantity of pumice-stone, all well ground separately rather stiff in raw oil; afterwards mix the whole, adding a little gold size, dilute with half raw oil and half turpentine, and apply a third, fourth, or fifth coat; repeat rubbing down with pumice-stone and water until smooth enough for painting upon.

Varnishing valuable Paintings.—Some artists employ for new paintings white of egg as a varnish, others do not varnish their paintings for one or two years after being finished, when the colours are completely hardened and mellow. Mastic varnish is the only one which can be removed at pleasure, and for that reason is generally preferred to all others, although it is very liable to chill; that is, it becomes all over of a bluish steamy hue, which obscures the beauty of the painting, and appears disagreeable to the eye. Many circumstances contribute towards causing it to chill; for instance, varnish made from weak, unripe gum mastic and common spirits of turpentine will chill, particularly if applied on new paintings, where the grounds, oils, and colours are fresh, soft, and absorbent. In order to prevent this, if possible, employ no varnish but that made from fine, ripe gum mastic and rectified turpentine. Varnish for oil paintings, after being properly made, ought to stand for at least twelve months in large wide-mouthed glass bottles, without a cork, covering the mouth with a piece of glass, so as to admit the air, but prevent dust falling in; place the bottle so as to receive a full light, but no sun. The light and air so change and modify the essential quality of the turpentine, that the varnish becomes elastic, clear, and brilliant, having so much improved during that time as seldom or never to chill or become steamy, and by age it loses that attraction which all new-made varnishes possess for moisture and impure exhalations. Therefore, as a preventive against varnish chilling, employ none but good old varnish; never apply it on new or old paintings until properly cleaned, and well dried from moisture; apply the varnish in a warm room, where the painting and varnish also receive a proper warmth; after the varnish is applied, let it remain until properly dry; recollecting that with all new-painted pictures, where the grounds and colours are soft and absorbent, and where the pictures are afterwards exposed to strong moist exhalations, the varnishing in time will chill; but when paintings are properly cleaned and varnished, and afterwards hung up in dry rooms or galleries, there is no reason to fear their chilling.

To Preserve a Scaling or Cracked Painting.—The preparation is a mixture of equal parts of linseed oil and methylated chloroform, which is to be poured over the painting if the colours are too brittle to bear the friction of a soft brush. After remaining on the surface of the painting for a day or two, the excess of oil may be removed by means of a piece of cotton-wool, or a soft brush, a fresh portion of the preservative applied, and the excess removed as before. The process must be repeated from time to time until the colours are firmly fixed, when the painting will bear friction, and

may be submitted to the cleaning process or varnished. It is advisable, however, to remove as much of the dirt as possible from the picture, by careful washing with soft water, previously to the application of the fixing agent. The mixture will not restore the cracks in a painting, but simply fixes the colours, and renders the painting very elastic. A mixture of one part of methylated chloroform and two of linseed oil is used for reviving the colours of paintings. A small portion is rubbed over the pictures, after washing, with cotton-wool, and on the following day the painting is wiped over with a soft silk handkerchief. Oil and chloroform, when used in the proportion given, possess the property of restoring the faded colours of paintings, and develop colours which have perished, to the eye, by age.

Drying Oils.—POPPY OIL.—Take 3 lbs. or pints of pure water, 1 oz. of sulphate of zinc (white vitriol), and 2 lbs. of poppy oil. Expose this mixture in an earthen vessel capable of standing the fire, to a degree of heat sufficient to maintain it in a slight state of ebullition. When one-half or two-thirds of the water has evaporated, pour the whole into a large glass bottle or jar, and leave it at rest till the oil becomes clear. Decant the clearest part by means of a glass funnel, the beak of which is stopped with a piece of cork: when the separation of the oil from the water is completely effected, remove the cork stopper, and supply its place by the forefinger, which must be applied in such a manner as to suffer the water to escape, and to retain only the oil. Poppy oil when prepared in this manner becomes, after some weeks, exceedingly limpid and colourless.

FAT DRYING OILS.—1. 8 lbs. nut oil or linseed oil, 1 oz. white-lead, slightly calcined, 1 oz. yellow acetate of lead, also calcined, 1 oz. sulphate of zinc (white vitriol), 12 oz. litharge, and a head of garlic or a small onion. When the dry substances are pulverized, mix them with the garlic and oil, over a fire capable of maintaining the oil in a slight state of ebullition; continue it until the oil ceases to throw up scum, assumes a reddish colour, and the head of garlic becomes brown. A pellicle will then be soon formed on the oil, which indicates that the operation is completed. Take the vessel from the fire, and the pellicle being precipitated by rest, will carry with it all the unctuous parts which rendered the oil fat. When the oil becomes clear, separate it from the deposit, and put it into wide-mouthed bottles, where it will completely clarify itself in time, and improve in quality. 2. $1\frac{1}{2}$ oz. of litharge, $\frac{3}{8}$ oz. sulphate of zinc, and 16 oz. linseed or nut oil. The operation must be conducted as in the preceding case. The choice of the oil is not a matter of indifference. If it be destined for painting articles exposed to the impression of the external air, or for delicate painting, nut oil or poppy oil will be requisite. Linseed oil is used for coarse painting, and that sheltered from the effects of the rain and of the sun. A little negligence in the management of the fire has often an influence on the colour of the oil, to which a drying quality is communicated; in this case it is not proper for delicate painting. This inconvenience may be avoided by tying up the drying matters in a small bag; but the dose of the litharge must then be doubled. The bag must be suspended by a piece of packthread fastened to a stick, which is made to rest on the edge of the vessel in such a manner as to keep the bag at the distance of an inch from the bottom of the vessel. A pellicle will be formed, as in the first operation, but it will be slower in making its appearance. 3. A drying quality may be communicated to oil by treating, in a heat capable of maintaining a slight ebullition, linseed or nut oil, to each lb. of which is added 3 oz. of litharge, reduced to fine powder. 4. 2 lbs. of nut oil, 3 lbs. of common water, and 2 oz. of sulphate of zinc. Mix these matters, and subject them to a slight ebullition, till little water remains. Decant the oil, which will pass over with a small quantity of water, and separate the latter by means of a funnel. The oil remains nebulous for some time; after which it becomes clear, and seems to be very little coloured. 5. 6 lbs. of nut oil

or linseed oil, 4 lbs. of common water, 1 oz. of sulphate of zinc, and 1 head of garlic. Mix these matters in a large iron or copper pan; then place them over the fire, and maintain the mixture in a state of ebullition during the whole day: boiling water must from time to time be added to make up for the loss of that by evaporation. The garlic will assume a brown appearance. Take the pan from the fire, and having suffered a deposit to be formed, decant the oil, which will clarify itself in the vessels.

RESINOUS DRYING OIL.—Take 10 lbs. of drying nut oil, if the paint is destined for external, or 10 lbs. of drying linseed oil, if for internal articles. 3 lbs. of resin, and 6 oz. of turpentine. Cause the resin to dissolve in the oil by means of a gentle heat. When dissolved and incorporated with the oil, add the turpentine: leave the varnish at rest, by which means it will often deposit portions of resin and other impurities; and then preserve it in wide-mouthed bottles. It must be used fresh: when suffered to grow old it abandons some of its resin. If this resinous oil assumes too much consistence, dilute it with a little essence, if intended for articles sheltered from the sun, or with oil of poppies.

Distemper for Photographic Backgrounds.—Take whiting, 1½ to 2 lbs.; lampblack, 3 oz.; damp blue, 4 oz.; glue, 1½ oz. Dissolve the whiting in 2 quarts of water, add nearly all the blue, then add the black, gradually drying after each addition by dipping in it a piece of paper and drying at the fire, till you get the exact colour required. Then having dissolved the glue in warm water, pour it in, to keep the colour from falling off, mix thoroughly together, and strain through canvas.

To Prepare Zinc for Painting.—Dissolve 1 part of chloride of copper, 1 of nitrate of copper, and 1 of sal ammoniac, in 64 parts of water, and add 1 part of commercial hydrochloric acid. Brush the zinc over with this, which gives it a deep black; leave to dry 24 hours, when any oil colour will firmly adhere to it, and withstand both heat and damp.

Vehicle for Colour.—1 oz. of borax, 2 oz. of shellac, 1 pint of water. Boil a few minutes, stir with a piece of wood; or 1 oz. of liquid ammonia, 2 oz. shellac, 1 pint of water. Add more or less shellac, as it may be required.

Putty.—Glaziers' putty is made of whiting and oil. The whiting should be in the form of a very dry fine powder; it should be specially dried for the purpose, and passed through a sieve of 45 holes to the inch, and then mixed with as much raw linseed oil as will form it into stiff paste; this, after being well kneaded, should be left for 12 hours and worked up in small pieces till quite smooth. It should be kept in a glazed pan and covered with a wet cloth. If putty becomes hard and dry, it can be restored by heating it and working it up again while hot. For special purposes white-lead is sometimes mixed with the whiting, or the putty is made of white-lead and litharge entirely.

Purifying Linseed Oil.—It is requisite that artists should have the linseed oil they use perfectly colourless, as otherwise it would spoil the more delicate tints. To purify it is extremely easy—even putting a bottle of the oil in the sun for some days will accomplish the object; but as this process is somewhat tedious, it is better to put in a 2-oz. phial three-quarters full of good common linseed oil, a piece of whiting as big as a nut, previously powdered. Shake them together, and put the phial on the hob of a stove, or in an oven. In two days, and sometimes in a few hours, the whiting will have carried down to the bottom all colour and impurity, and the refined oil floating at top may be poured off for use.

Silicate of Soda Paint.—A solution of silicate of soda has been found by Abel, when applied like paint to wood, to give it a very considerable protection against fire, as well as to form a hard coating durable for several years; it can be used with the ordinary colours like distemper. The silicate of soda must be in the form of a thick syrup of a known degree of concentration, and is diluted with water when

required for use, according to the prescription given below. The lime-wash should be made by slaking some good fat lime, rubbing it down with water until perfectly smooth, and diluting it to the consistency of thick cream. It may be coloured by admixture with mineral colours. The protective coating is produced by painting the wood, firstly with a dilute solution of silicate of soda; secondly, with a lime-wash; and lastly, with a somewhat stronger solution of the silicate. The surface of the wood should be moderately smooth, and any covering of paper, paint, or other material, removed entirely, by planing or scraping. A solution of the silicate, in the proportion of 1 part by measure of the syrup to 4 parts of water, is prepared in a tub, pail, or earthen vessel by stirring the measured proportion of the silicate with a very small quantity of the necessary water until a complete mixture is produced, and then adding the remainder of the water, in successive quantities, until a perfect mixture in the requisite proportions is obtained. The wood is then washed over with this liquid, by means of an ordinary whitewash brush, the latter being passed two or three times over the surface, so that the wood may absorb as much of the solution as possible. When this first coating is nearly dry, the wood is painted with the lime-wash in the usual manner. A solution of the silicate, in the proportion of 1 part by measure of the syrup to 2 parts of water, is then made as above described, and a sufficient time having been allowed to elapse for the wood to become moderately dry, this liquid is applied, upon the lime, in the manner directed for the first coating. The preparation of the wood is then complete. If the lime coating has been applied rather too thickly, the surface of the wood may be found, when quite dry after the third coating, to give off a little lime when rubbed with the hand. In that case, it should be once more coated over with a solution of the silicate of the first-named strength.

To Line Old Paintings.—1. Take a piece of unbleached calico, strain upon a frame, and size it with weak size. When dry, take ¼ oz. spirits of turpentine, 1 drachm camphor, dissolve in it 4 oz. cold-drawn linseed oil, 2 oz. white-lead, stiff ground do. umber, 4 oz. finely-washed and dried whiting. Mix all together; apply to the calico well, rubbing it in; after the second coat, pumice to erase the lumps. Give the picture a coat, and pumice that; then coat both, and put them together upon a level board face down upon a piece of brown paper well sized. Well press, and rub the air out, so as to bring them in perfect contact, and in a few days it may be tacked upon a frame. 2. Make a temporary stretcher, and let it measure inside a little larger than the outside of the picture about to be lined, and on it stretch some unbleached calico; trim the picture square, cutting off all the old nails and ragged edges. Oil a piece of paper the size of picture with linseed oil, and lay it on a flat surface; now lay the picture face downwards on the oiled paper, and coat it with glue or paste until there is sufficient to make it stick well; then lay the unbleached calico on, rub well with the flat of the hand, iron it with flat iron till quite dry, taking care to put a piece of paper between the calico and the iron, or it may stick. Be sure the iron is not too hot; and if it is a large picture, it will be as well to have two irons, one getting hot while the other is in use. When the picture is quite dry it is ready for putting on the new stretcher, which should be one with two cross-bars, and can be obtained at any artist's colourman's. If you cannot make some good stout paste yourself, you had better buy it at the leather seller's, and add glue enough to make it a good strength, and let the two be well mixed together.

Ox-Gall Purifying.—Evaporate fresh ox-gall to a syrup, and then spread it out to dry in a thin layer on a plate placed near the fire. This is the pharmacopœia plan, but it takes none of the colour out of ox-gall. It simply desiccates the bile, which can in this condition be preserved from putrefaction for any length of time in closely-stop-

pered bottles. If fresh ox-gall is evaporated to dryness on a water bath, and then treated with alcohol, the mucus and epithelium are precipitated; but the colouring matter still exists, and is not precipitated or discharged by digesting. Again, boil 1 pint of fresh ox-gall with 1 oz. of alum, and in another vessel a second pint, with 1 oz. of common salt. After standing three months in separate bottles, the clear portion from these solutions is to be mixed for use. But the solutions do not become altogether clear, although they keep very well without putrefaction. Ox-gall may be thoroughly discolorized by slightly acidulating it with acetic acid, and passing through it a stream of chlorine gas.

To Remove Old Paint.—Wet the place with naphtha, repeating as often as is required; but frequently one application will dissolve the paint. As soon as it is softened, rub the surface clean. Chloroform, mixed with a small quantity of spirit ammonia, composed of strong ammoniac, has been employed very successfully to remove the stains of dry paint from wood, silk, and other substances.

To Destroy Paint.—Mix 1 part by weight of American pearlash with 3 parts quick stone lime, by slaking the lime in water and then adding the pearlash, making the mixture about the consistence of paint. Lay the above over the whole of the work required to be cleaned, with an old brush; let it remain 14 or 16 hours, when the paint can be easily scraped off.

Fireproofing Shingle Roofs.—A wash composed of lime, salt, and fine sand or wood-ashes, put on in the ordinary way of whitewash, renders a shingle roof fiftyfold more safe against fire from falling cinders, in case of fire in the vicinity. It has also a preserving influence against the effect of the weather; the older and more weather-beaten the shingles, the more benefit derived. Such shingles are generally more or less warped, rough, and cracked. The application of wash, by washing the upper surface, restores them to their original or firm form, thereby closing the space between the shingles, and the lime and sand, by filling up the cracks, prevent it warping. By the addition of a small quantity of lampblack, the wash may be made of the same colour as old shingles, and thus the offensive glare of a whitewashed roof is removed.

Remedy for Damp Walls.—¾ lb. of mottled soap to 1 gall. of water. This composition to be laid over the brickwork steadily and carefully with a large flat brush, so as not to form a froth or lather on the surface. The wash to remain 24 hours, to become dry. Mix ½ lb. of alum with 4 galls. of water; leave it to stand for 24 hours, and then apply it in the same manner over the coating of soap. Let this be done in dry weather.

To Whitewash, or Colour-wash.—If a room is to be whitewashed or coloured, the walls and ceiling are to be washed with clean water, frequently changed, the rough patches scraped smooth, swept with a broom, and all cracks and loose places carefully stopped. When this is done, before proceeding further, all the rubbish should be cleared from the room and the floor swept. In some instances, as after illness, it will be the best to make the whitewash of lime, for lime is a good purifier. But as lime-wash is apt to turn black, whitewash is generally made by putting whiting to soak in water overnight, and afterwards mixing very smooth, as thick as cream, and with about a teacupful of size to 2 galls. of wash, which will prevent its rubbing off when dry: or potato starch may be used, which leaves the white uninjured. Another mode is to mix into a stiff paste, with cold water, 6 balls of whiting; to this add 2 lbs. of very hot, but not boiling, size, and a small quantity of blue black ground fine, and let the whole get cold. Whitewash thus prepared may be altered to any required colour: yellow ochre mixed with a small quantity of blue black makes a stone-colour; without the black, a buff or straw colour; and warmer tints may be produced by using indigo or the blue black above mentioned, or Venetian or

orange red; vermilion will give different shades of pink, and a green may be obtained with mixture of indigo and yellow ochre. Some care will be required in the mixing, but if too much of the colouring matter is not added at first, it will not be difficult to get a colour according to taste. By a little management the wash may be laid on without splashing, the method being, not to take too much at a time into the brush, or to jerk it at the end of the stroke. As a rule, ceilings or walls should be whitewashed at least once a year, and oftener whenever necessary. For common work a mixture of ½ a bushel of lime, 1 lb. of common salt, ½ lb. of sulphate of zinc, and a gallon of sweet milk can be used. For brickwork exposed to damp, take ½ a peck of well-burnt lime, fresh from the kiln, slake with water, then add a sufficient quantity of water to reduce it to a paste, pass through a fine sieve; add a gallon of clean white salt, which has been dissolved in boiling water, and a thin smooth paste, also hot, made from 1 lb. of fine rice flour; also ¼ lb. of best glue, made in a water bath. Mix these ingredients all together, stir them well, and then add ¼ lb. of best Spanish whiting dissolved in 5 qts. of boiling water. Stir again, and cover over to retain the heat and keep out dirt. Let it stand a week, when boil again and apply hot. The above proportions will suffice to cover 40 square yards.

Paper Hanging.—If the walls are quite new and smoothly finished, the only preparation usually necessary is to lay on a thin coat of weak size, the use of the size being to make a surface to which the paper will stick better than to the bare wall. In preparing an old whitewashed or coloured wall for paper, the wash or colour is wetted with water and scraped off with an old plane-iron, or any piece of steel which has a smooth edge, after which the wall should be swept down with a stiff broom to remove all that the scraper may have left and make an even surface. If there is any loose plaster, those parts should be well sized and have a piece of thin strong paper pasted over them; but the best way is to get the place re-plastered. Cracks or holes may easily be filled with a little putty; in no case should they be left. If not stopped in any other way, slips of paper should be pasted over them, or else the cracks will soon show through the outer paper. After all this is done the room may be sized, and the size will be dry enough in an hour for the papering to be commenced. If the room has been already papered, it will be necessary to go over the walls and tear off all the loose pieces, especially at the top and bottom, corners and edges. If the bare wall is exposed by the tearing off, these spots should be sized. The walls of rooms finished in a superior manner are generally plastered three coats, and upon the plaster, when quite dry, a coating of lining-paper is laid to obtain a smooth surface. Sometimes common thin canvas is used instead of lining-paper, and occasionally instead of plaster. In the latter case battens should be fixed against the walls to fasten the canvas to and prevent it touching the walls. The preparations having been made, the hanging of the paper may be proceeded with: the rule is, that the edges of the paper, when hung, shall be towards the window. The appearance of many a handsome paper has been spoiled from carelessness or ignorance in this particular; but when this precaution is observed, the lapped joints scarcely show. First of all, the edges of the paper are to be cut, and as the hanging is to begin at the window on each side, that edge which is cut close for one side must *not be cut close for the other.* This point being decided, unroll a yard or two of one of the pieces of paper, cut the edge, unroll a yard or two more, roll up loosely the part that is cut, and continue till the end is reached, when the process being repeated with the other edge, the piece will be at last rolled up again as it was at starting. Not more than about a ¼ inch of paper should be left at the edge which is not cut close. If there is a back and a front window in the room, the same rule must be observed, and the finish will come in the corner most out of sight, by the mantel-

piece, or at the back of the folding doors. When the edges are finished, the paper is to be cut into lengths, about ½ an inch longer than the height of the room; but they must be cut so that the second will match the first, and so on. There are certain dots or marks on the edges which show where the match is, and if the length required comes between these dots, the portion down to the next dot must be cut off after each length, which will bring the match the same as where it started in the first length. Care should be taken to cut straight across, and as many lengths may be cut as will be sufficient for two sides of the room. These are to be turned altogether the plain side uppermost, and the first one may be pasted. If the paper is thin and common, it must be put on the wall immediately; but if of good quality, it is to be left to soak for two or three minutes, while for a stiff glazed or flock paper, from five to eight minutes would not be too much. The reason is, to give time for both sides to become equally damp, otherwise there is no certainty that the paper will stick. The first length is to be put up with the close-cut edge close to the woodwork round the window. Having brought the top to meet the ceiling, see that the length hangs straight, trying it if necessary by a plumb-line, then taking it by the lower end, lift it away from the wall all but about 3 inches at the top, then let it fall, and it will drop into its place without a wrinkle. Now with a soft clean cloth begin at the top and press the paper to the wall all down the centre to the bottom, then beginning from the top again, press it from the centre to each side alternately, regularly downwards. If this operation be properly done, the length will be perfectly close to the wall and smooth in every part. It is not to be pressed heavily; but the cloth being taken in the hand as a round loose lump, must be moved quickly over the surface—dab—dab—dab—with a light and clean touch, otherwise some of the colours will be apt to smear. Last of all, mark with the end of the scissors where the paper meets the skirting, cut off all that is over, and press the end carefully into its place. Proceed with the second length in the same way, bringing the close-cut edge to meet the pattern of the first one, and taking care that no gap is left between. Neglect of these precautions will convert a handsome paper into a sight that will be a constant eyesore. Try the lengths frequently with the plumb-line to avoid the chance of getting out of upright, and remember that the outside end of the piece is always the top of the paper. *Paste* is best made with old flour, water, and a little size or glue; alum is also added to paste to make it spread more freely without losing any of its tenacity or sticking quality; it should never be used while warm. The paste should be rather thicker than ordinary gruel, and laid on smoothly and equally, not putting too much, or it will squeeze out at the edges. Where this takes place, it must be removed with a clean damp sponge: any accidental smears of paste may be removed in this way, if taken off lightly as soon as they are made. Decorative paper for covering the walls of rooms is manufactured in *pieces*, which are 12 yards long and 20 inches wide.

Pavements.—Asphalte pavements made with Val de Travers compressed asphalte are laid as follows. A foundation is formed of cement or lime concrete, varying from 6 inches to 9 inches in thickness, according to the traffic. The mineral rock in its natural state, and without admixture with other ingredients, after being broken into small lumps is brought to a state of dry powder by subjecting it to considerable heat in revolving ovens: it is then put into iron carts with close-fitting covers, and brought on to the works, taken out, laid over the surface, and whilst hot compressed with heated irons into one homogeneous mass without joints. The finished thickness varies from 2 to 2¼ inches, according to the traffic of the place in which it is laid, and it further compresses and consolidates under the traffic. Val de Travers liquid asphalte is laid upon a concrete bed 6 inches thick, the asphalte surface being 1½ inch thick. The rock is first ground to a fine

powder, and being then placed in caldrons, from 5 to 7 per cent. of bitumen is added to solve it; heat being then applied, it forms into a semi-fluid or mastic state, and when in that condition about 60 per cent. of grit or dry shingle is added to it, and after being thoroughly mixed together, the compound is spread over the concrete in one thickness. With *Limmer asphalte*, a concrete foundation 9 inches thick is first formed, and the asphalte is used in certain proportions by the judgment of those directing the work; it is broken up and mixed with clean grit or sand of different sizes according to the place in which the pavement is to be laid; a small quantity of bitumen is then added to the materials, which are placed in caldrons on the spot, made liquid by heat, and the compound is run over the surface and smoothed with irons to the proper slopes and curvatures. It is run in two thicknesses, the lower stratum being made with grit of a larger size than that of the upper. The total thickness of the asphalte, when finished, is from $1\frac{1}{2}$ to 2 inches.

Barnett's Liquid Iron Asphalte can be made either of natural or artificial asphalte, mixed with pulverized iron ore or sesquioxide of iron and a small proportion of mineral tar. The materials are put into a caldron which is brought on to the works, and are made into a liquid state by heat, run over the surface, and smoothed in the same way as the other liquid asphaltes mentioned; the thickness usually laid is about 2 inches.

Tar Pavement.—Made by mixing with fine breeze, or small coke, just enough of thick refuse coal-tar to make it somewhat sticky; put a thin layer on the smooth and hardened surface, on this spread a couple of inches of metal, or pebbles, or coarse gravel, then a thin layer of the prepared breeze, covered lightly with fine gravel, and beat or press together. It is cheap, slightly elastic, and durable.

Concrete Pavements.—1. The terraza floors used in Italy at the present day are made in the following manner:—1st coat; a concrete consisting of common lime $\frac{1}{4}$, sand and fine gravel $\frac{3}{4}$, laid 6 inches thick and well beaten with wooden rammers; after two days in that climate, it is sufficiently dry for the next coat. 2nd coat; a terraza, consisting of pounded brick or tile $\frac{1}{6}$, common lime $\frac{2}{6}$, sand $\frac{3}{6}$, of the consistency of mortar, laid $1\frac{1}{4}$ inch thick, well beaten with a light flat rammer. After two or three days it is hard enough for the next coat. 3rd coat; a similar terraza, but with the grit of broken stones instead of sand in it, laid on like a coat of plaster with a trowel. After this has been laid for one day, a layer of small hard broken stones is pressed into it; these stones should be of some substance that will take a polish, and be of uniform size (they are passed through a gravel screen of about a walnut; these being afterwards rubbed to a smooth even surface with some smooth hard stone, form a kind of mosaic-work; the stones are frequently selected by colour, and laid in the third coat to a rough pattern. They should be moistened with oil or water till hard set. 2. Dig the earth out about 8 inches, fill in with coarse gravel and stones, well rammed, and levelled about 5 inches. Mix Portland cement to the consistence of cream and pour over, spreading it with a stiff broom; when hard mix finer gravel with cement and water, and fill up to within $\frac{3}{4}$ inch of the surface; when hard mix clean sharp sand and Portland cement, half-and-half, with water to about the thickness of mortar, and finish, slightly rounding. It should not be walked on for a day or two. Cement must be Portland, and fresh.

Lathing and Plastering.—The plaster used for covering the walls of buildings is a mortar composed of lime or cement, and sand, mixed in various proportions, generally with a little hair or some such material to give it elasticity. It is laid on by hand with a trowel in several thicknesses of about $\frac{1}{8}$ to $\frac{1}{4}$ inch each, and either on the bare masonry wall or on a special screen of *lathing* made for it, to either of which it adheres by entering into and keying itself in the joints and openings, and by its adhesive quality. With some variations in the materials and mixing, it is used for exterior and interior work and for ceilings. For the

purpose of assisting to keep the interior of the rooms of a house dry, it is advantageous to employ lathing, which being detached from the masonry of the walls forms a lining, distinct in itself, and not liable to the effect of moisture which may be in the walls. It is of the utmost importance, in plasterers' work, that the lime should be most thoroughly slaked, or the consequence will be blisters thrown out upon the work after it is finished. Many plasterers keep their stuffs a considerable period before they are wanted to be used in the building, by which the chance of blistering is much lessened. When a wall is to be plastered, it is called rendering; in other cases the first operation, as in ceilings, partitions, &c., is

Lathing, nailing the laths to the joists, quarters, or battens. If the laths are of oak, wrought-iron nails must be used for nailing them, but cast-iron nails may be employed if the laths are of fir. The lath is made in 3 or 4 foot lengths, and, according to its thickness, is called single, something less than a ¼ of an inch thick, lath and half, or double. The first is the thinnest and cheapest, the second is about one-third thicker than the single lath, and the double lath is twice the thickness. When the plasterer laths ceilings, both lengths of laths should be used, by which, in nailing, he will have the opportunity of breaking the joints, which will not only help in improving the general key (or plastering insinuated behind the lath, which spreads there beyond the distance that the laths are apart), but will strengthen the ceiling generally. The thinnest laths may be used in partitions, because in a vertical position the strain of the plaster upon them is not so great; but for ceilings the strongest laths should be employed. In lathing, the ends of the laths should not be lapped upon each other where they terminate upon a quarter or batten, which is often done to save a row of nails and the trouble of cutting them, for such a practice leaves only a ¼ of an inch for the thickness of the plaster; and if the laths are very crooked, which is frequently the case, sufficient space will not be left to straighten the plaster.

Laying.—After lathing, the next operation is laying, commonly called plastering. It is the first coat on laths, when the plaster has two coats or set work, and is not scratched with the scratcher, but the surface is roughed by sweeping it with a broom. On brickwork it is also the first coat, and is called rendering. The mere laying or rendering is the most economical sort of plastering, and does for inferior rooms or cottages. What is called pricking up is the first coat of three-coat work upon laths. The material used for it is

Coarse Stuff, being only the preparation for a more perfect kind of work. Coarse stuff is made with chalk-lime prepared as for common mortar, but slaked with a quantity of water, afterwards evaporated, mixed with an equal quantity of clean, sharp sand and ox-hair, at the rate of 1 lb. of hair to 3 cub. feet of stuff. After the coat is laid on, it is scored in diagonal directions with a scratcher (the end of a lath), to give it a key or tie for the coat that is to follow it.

Lath layed or *plastered and set* is only two-coat work, as mentioned under laying, the setting being the gauge or mixture of putty and plaster, or, in common work, of

Fine Stuff, with which, when very dry, a little sand is used. Fine stuff is a mortar made of fine white lime exceedingly well slaked with water, or rather formed into a paste in water to make the slaking complete: for some purposes a small quantity of hair is mixed up with it. Fine stuff very carefully prepared, and so completely macerated as to be held in solution in water, which is allowed to evaporate till it is of sufficient consistence for working, is called putty, plasterers' putty.

Setting may be either a second coat upon laying or rendering, or a third coat upon *floating*, which will be hereafter described. The term finishing is applied to the third coat when of stucco, but setting for paper. The setting is spread with the smoothing trowel, which the workman uses with his right hand, while in his left he uses a large flat-formed brush of hog's bristles. As he lays on the putty or set

with the trowel, he draws the brush, full of water, backwards and forwards over its surface, thus producing a tolerably fair face for the work.

Floating.—Work which consists of three coats is called floated: it takes its name from an instrument called a float, which is an implement or rule moved in every direction on the plaster while it is soft, for giving a perfectly plane surface to the second coat of work. Floats are of three sorts: the hand float, which is a short rule that a man by himself may use; the quirk float, which is used on or in angles; and the Derby, which is of such a length as to require two men to use it.

Plaster, float and set is the term for three coats of plaster on laths. The first or pricking-up coat is of coarse stuff put on with a trowel to form a key behind the laths, and about $\frac{1}{4}$ or $\frac{3}{8}$ inch thick on the laths: while it is still moist it is scratched or scored all over with the end of a lath in parallel lines 3 or 4 inches apart, the scorings being made as deep as possible without exposing the laths; the rougher the edges are the better, as the object is to produce a good key for the next coat. When the pricking-up coat is sufficiently dry not to yield to pressure in the slightest degree, the second coat or floating is put on. The floating is of fine stuff with a little hair mixed with it; ledges or margins, 6 or 8 inches wide, and extending across the whole width of a ceiling or height of a wall, are made at the angles and at intervals of about 4 feet apart throughout: these must be made perfectly in one plane with each other with the help of straight-edges. These ledges are technically called screeds. They form gauges for the rest of the work, and when they are a little set the spaces between them are filled up flush, for which a Derby float or a long straight-edge is used. The screeds on ceilings ought to be levelled, and those on the walls plumbed. When the floating is sufficiently set it is swept with a birch broom for the third coat or setting. The third, or setting coat, should be of plasterers' putty if the ceiling or wall is to be whitened or coloured. If it is to be papered, the third coat should be of fine stuff, with a little hair in it. If it is to be painted, the third coat should be of bastard stucco trowelled.

Bastard stucco is of three coats, the first is roughing in or rendering, the second is floating, as in trowelled stucco; but the finishing coat contains a small quantity of hair behind the sand. This work is not hand-floated, and the trowelling is done with less labour than what is termed trowelled stucco.

Trowelled stucco, which is the best sort of plastering for the reception of paint, is formed on a floated coat of work, and such floating should be as dry as possible before the stucco is applied. In the last process, the plasterer uses the hand float, which is made of a piece of half-inch deal, about 9 inches long and 3 inches wide, planed smooth, with its lower edges a little rounded off, and having a handle on the upper surface. The ground to be stuccoed being made as smooth as possible, the stucco is spread upon it to the extent of 4 or 5 feet square, and moistening it continually with a brush as he proceeds, the workman trowels its surface with the float, alternately sprinkling and rubbing the face of the stucco, till the whole is reduced to a fine even surface. Thus, by small portions at a time, he proceeds till the whole is completed. The water applied to it has the effect of hardening the face of the stucco, which, when finished, becomes as smooth as glass.

Ceilings are set in two different ways; that is the best wherein the setting coat is composed of plaster and putty, commonly called gauge. Common ceilings are formed with plaster without hair, as in the finishing coat for walls set for paper

Pugging is plaster laid on boards, fitted in between the joists of the floor to prevent the passage of sound between two stories, and is executed with coarse stuff. In the country, for the interior coating of dwellings and outbuildings, a species of plastering is used called roughcast. It is cheaper than stucco or Parker's cement, and therefore suitable to such purposes. In the process of executing it, the wall is first pricked up with a coat of lime and hair, on which, when tolerably well set, a second coat is laid on of the same materials as the first, both as smooth as pos-

sible. As fast as the workman finishes this surface, another follows him with a pailful of the roughcast, with which he bespatters the new plastering, so that the whole dries together. The roughcast is a composition of small gravel, finely washed, to free it from all earthy particles, and mixed with pure lime and water in a state of semi-fluid consistency. It is thrown from the pail upon the wall, with a wooden float, about 5 or 6 inches long, and as many wide, formed of ½-inch deal, and fitted with a round deal handle. With this tool the plasterer throws on the roughcast with his right hand, while in his left he holds a common whitewashers' brush dipped in the roughcast, with which he brushes and colours the mortar and the roughcast already spread, to give them, when finished, a uniform colour and appearance.

Builders' Waterproof Mastic Cement.—1. 5 parts river sand; 5, ground stone lime; 10, red-lead, in powder. 2. 10, sand; 5, powdered whiting; 1, powdered red-lead. 3. 100, sand; 25, plaster of Paris; 10, red-lead; 5, yellow ochre, all in powder. Each of these cements must be mixed with boiled oil.

Concrete for Foundations.—5 parts gravel and sand to 1 part fresh-burned stone lime, ground to powder, without slaking, and measured dry. Well turn and shovel together, with sufficient water to slack the lime into the state of very thick mortar. Chips and small pieces of stone may be added with advantage.

CONCRETE FOR MASONRY.—1. Screened sand, 9 parts by measure; slaked lime, 7; forge ashes, 1; puzzolana, 1. 2. 1, slaked lime; 1, sea sand; ½, furnace ashes.

CONCRETE FOR BRICKWORK.—Slaked lime, 7 parts by measure; sand, 12 parts.

Hydraulic Mortars.—1. 2½ parts burnt clay; 1 part blue lias lime, pulverized and ground together between rollers. Use immediately 2. 2 parts fresh stone lime; 3, wood ashes, mixed as for common mortar, but must lie until cold and be beaten several times before being used. 3. 4 parts blue lias lime. 6, river sand; 1, puzzolana; 1, calcined ironstone.

BUILDERS' MORTAR.—1. 3 parts by measure of good sharp sand to 2 parts grey stone lime, mixed with water, or 2 of sand to 1 chalk lime. Sharp road scrapings may be used instead of sand; and where taken from roads kept in order with flint or gravel, form a very good mortar. 2. 1 part grey stone lime to 3 river-sand coarse mortar. 3. 1, stone lime; 4, coarse gravelly sand. 4. 1, lime; 2, river sand; 1, blacksmiths' ashes. 5. 1, lime; 2, sand; 1, rough ground coke.

Composition for Picture Frames.—1. To make compo ornaments for picture frames: Boil 7 lbs. of the best glue in 7 half-pints of water, melt 3 lbs. of white resin in 3 pints of raw linseed oil; when the ingredients are well boiled put them into a large vessel and simmer them for half an hour, stirring the mixture and taking care that it does not boil over. When this is done, pour the mixture into a large quantity of whiting, previously rolled and sifted very fine, mix it to the consistence of dough, and it is ready for use. 2. Dissolve 1 lb. of glue in 1 gall. of water; in another kettle boil together 2 lbs of resin, 1 gill of Venice turpentine, and 1 pint of linseed oil; mix altogether in one kettle, and continue to boil and stir them together till the water has evaporated from the other ingredients; then add finely-pulverized whiting till the mass is brought to the consistence of soft putty. This composition will be hard when cold, but being warmed, it may be moulded to any shape by carved stamps or prints, and the moulded figures will soon become dry and hard, and will retain their shape and form permanently.

Firework Making.—The three prime materials of the art of pyrotechny are nitre, sulphur, and charcoal, along with filings of iron, steel, copper, zinc, and resin, camphor, lycopodium, &c. Gunpowder is used either in grain, half crushed or finely ground, for different purposes. The longer the iron filings,

the brighter red and white sparks they give; those being preferred which are made with a coarse file and quite free from rust. Steel filings and cast-iron borings contain carbon, and afford a very brilliant fire, with wavy radiations. Copper filings give a greenish tint to flame; those of zinc, a fine blue colour; the sulphuret of antimony gives a less greenish blue than zinc, but with much smoke; amber affords a yellow fire as well as colophony and common salt, but the last must be very dry. Lampblack produces a very red colour with gunpowder, and a pink with nitre in excess. It serves for making golden showers. The yellow sand, or glistening mica, communicates to fireworks golden radiations. Verdigris imparts a pale green; sulphate of copper and sal ammoniac, a palm-tree green. Camphor yields a very white flame and aromatic fumes, which mask the bad smell of other substances. Benzoin and storax are used also on account of their agreeable odour. Lycopodium burns with a rose colour and a magnificent flame.

Iron tools must never be used in making fireworks of any kind, as they are liable to throw out sparks when striking against a hard stony substance, besides which the sulphur used would injure the iron. Brass tools may be used, but copper tools are preferable.

Rockets.—Of all fireworks, rockets are among the most noble and effective. The ingredients for these, the apparatus employed, and the detail of the manufacture of them may be considered the foundation of all fireworks, and to make them well involves the same principles, and requires the same caution, as in making all others.

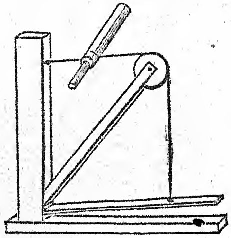
Size of Rockets.—The size of rockets is indicated by ounces or pounds; thus we say, an eight-ounce rocket, a pound rocket, and so on; by this expression it is not meant that the rockets weigh so much as their name indicates, but that the bore or cavity will just suffer a leaden bullet of that weight to pass down them. For example, a pound rocket will admit a leaden bullet that weighs a pound. Rockets may be made of any size from 1 oz. up to 50 or more pounds.

Rocket Cases or Cartridges.—These may be made of any kind of stiff thick paper, either cartridge paper or what is equally good and much cheaper, namely, common bag-cap paper. To roll up the cases you must have a smooth round ruler, or, as it is called, a former, exactly the size of the cavity of the rocket, and 10 or 12 times as long. Then lay a sheet of the paper upon a slab of slate, marble, or glass, and paste 4 or 5 in. along the end of it, leaving the rest of the sheet of paper without paste; then roll it smoothly over the former, dry end first, until the whole is rolled up, when of course the paste will stick and a thin case be formed. Keep rolling it along the slab with the hands, in the same way as a rolling-pin is used, for two or three minutes, until the various folds of the paper set close and tight to each other; then put on another sheet in the same way, and so on, till the case is thick enough. This is known by the measurement across it. If the former without the case measures five parts, when the case is upon it they must measure together eight parts. That is, the paper must be rolled on till it forms a case, the thickness of the sides of which are a trifle more than one-third of the thickness of the former. The length of the rocket case, and consequently the width that the sheets of brown paper are to be cut before pasting, varies with the size of the rockets; in small rockets the length of the case may be six times the diameter, in larger rockets four or five times is sufficient. When the case has proceeded thus far, it is to be choked while yet damp, that is, to be contracted in diameter near one end, and for this purpose a simple contrivance is requisite, called a choking cord, and also the former is made with a hole drilled at one end, and a second joint made to fit on by means of a wire projecting at one end of it, and which fits into the hole of the former, Fig. 10. To choke the case, draw the former partly out, until you can see about 1 inch of the inner cavity of the

case, then put on the second joint (the wire of which fits into the hole of the former), and pass this on until its end is

FIG. 10.

FIG. 11.



about ½ an inch within the case, leaving a space of about ½ an inch between the two joints occupied by the wire alone. Then going to an apparatus similar to that shown in Fig. 11, turn the cord once round the case where the cavity is, put the foot upon the treadle, which tightens the cord and squeezes the paper case at the point required, and that it may squeeze it equally and neatly on all sides the case should be held in the hands and moved up and down upon the cord until the operator sees that it is sufficiently and properly compressed. Let it be observed that although the choking apparatus used by the firework maker is represented and above alluded to, yet to the amateur it is by no means necessary. What will do quite as well is a thin cord fastened at one end to a staple in the wall, and by the other tied round the waist of the operator; as he may lean back, of course the cord would be tightened, and the desired purpose accomplished. When the case is sufficiently compressed it is to be tied with two or three turns of strong string. The case is now complete, except that the part of it where it is choked is perhaps rather rough and uneven inside; this must be compressed down, for much of the effect of the rocket will depend upon the perfect regularity on this part, as it is through the hole left by the wire in the middle of the choke that the fire is afterwards to issue. To compress this part properly a mould is necessary.

The Rocket Mould is represented in Fig. 12. It consists of a solid foot of wood; upon the centre of this stands a short cylinder about ½ an inch high, and exactly of the size of the mould, to be placed over it, as afterwards described;

FIG. 12.

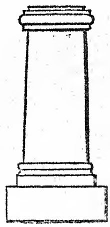
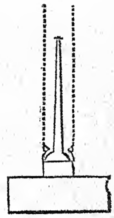


FIG. 13.



this short cylinder has a shoulder above, and terminates in a round top. Out of the middle of the top is a tapering thick brass wire, projecting some inches upwards, as is seen in Fig. 13. The whole is so arranged, that when one of the newly-made cases is put upon the wire and forced down, the wire fills up the choke-hole, the round top fits into the small parts of the case below the choke, the shoulder of the cylinder bears the extreme end of the case, and the short cylinder agrees in size with the outsides of the case. There fits over this (case and all) a strong wooden or metal tube; so that it is seen that there is no cavity anywhere, except the inside of the rocket case, and even in this a thick wire runs up to nearly the top of that part of the case where the composition is rammed, or nearly ⅔ of the whole case from the choke upwards. The wire above mentioned is called the piercer. All rockets must be placed in the mould to be filled, as well as to smooth and consolidate the part choked. With the mould are used rammers, Fig. 14, formed of hard wood, of the shape of a popgun-stick; these rammers being rather less than the diameter of the cavity, and having a hole bored up their centre, in order to admit the piercer. It is evident that

FIG. 14.

there must be a complete mould, piercer, and one or more rammers for every size rocket. But to proceed with the string; put it in the mould and the rammer down into it, and give this, the latter, a blow or two with a mallet, which driving it down while yet damp with the paste, will render the whole compact and smooth; and the case being taken out may be placed in an oven, or near the fire, to dry. If it is desired to ornament it in any way or cover it with white paper, this must be done before choking.

Charging Rockets.—The next process after drying the case is to charge them with the requisite composition. Put the cases in the mould with the piercer in it and put enough composition in to fill about 1 inch of the case; then, taking the rammer, ram it down with three or four strong blows with a mallet. Then put in the same quantity of composition again and ram that down in the same manner, and so on till the case is filled to the top of the piercer and one diameter above it. Then separate some of the central folds of the paper which it has been observed is not parted, and turn them down upon the composition, ramming them down hard upon it, or, what will do as well, put in a piece of paper as wadding. When this is rammed down, and firm, bore with a brass bradawl three or four holes through it. These holes serve to make the requisite communication between two parts of the rocket. Or, having charged the case, take some common potters' clay in dry powder, and ram it down hard upon the top of the composition, then bore a hole through it about $\frac{3}{16}$ of an inch diameter, which will allow of the necessary connection between the rammed composition and the stars in the head or pot of the rocket.

Priming Rockets.—The rocket is now supposed to be closed at one end. It only requires to be primed at the other end, and that it will be observed is the end which was choked, which is still open, and which has a hole passing up it which the piercer occupied. To prime it fill up the hole with loose gunpowder made into a stiff paste with very weak gum water, and paste a piece of touch-paper over it.

Rocket Pot or Head.—The rocket being then charged, the head or pot must be fixed. The pot is a paper case made upon a wooden former turned cylindrical, about 4 inches in length, and a shade larger in diameter than the exterior of the rocket case. Take some thick brown paper and cut it in strips large enough to go twice round the former, paste and roll as for the case, then pinch one end, and a cylinder of paper will be thus made which should fit nicely over the clay end of the rocket. There should now be fixed upon the pinched end a conical cap, made upon a former of like shape, Fig. 15. This cap by cleaving the air assists the rocket in rising into it.

Fig. 15.

Loading Rockets. — The loading the pots with stars is all that now remains to be done to complete the rocket. A $\frac{1}{4}$-lb. rocket should carry about 1 oz. of stars. Weigh out the proper quantity of stars and mix them with meal powder, 6 parts, to fine charcoal 1 part, fill up the pot and glue it securely over the clay or upper end of the rocket case.

Rocket Sticks.—Next fasten the stick to the rocket by two strings, as seen in any of the figures 16 to 19.—The sticks

Fig. 16.

Fig. 17.

Fig. 18.

being previously prepared of proper length and size, as follows:—The smaller

ones are easily and best made of those laths called by bricklayers double laths,

FIG. 19.

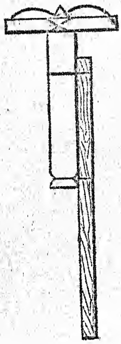


FIG. 20.

and the larger ones pantile laths; but any slip of deal will answer the purpose. 2-lb. rockets require sticks 9 feet 4 inches long, 1 inch square at top, and rather more than $\frac{1}{2}$ inch square at bottom. 1-lb. rocket sticks are 8 feet 2 inches long, $\frac{3}{4}$ inch square at top and $\frac{2}{3}$ inch at bottom. 8-oz. rocket sticks are 6 feet 2 inches long, $\frac{3}{4}$ inch square at top, and $\frac{2}{3}$ inch at bottom. 4-oz. rocket sticks are 5 feet 3 inches long, $\frac{2}{3}$ inch by $\frac{1}{2}$ inch at top, and $\frac{1}{4}$ inch square at bottom. 2-oz. rocket sticks are 5 feet 1 inch long, $\frac{3}{10}$ inch by $\frac{1}{2}$ inch at top, $\frac{4}{10}$ inch at bottom. 1-oz. rocket sticks 3 feet 6 inches long, and so on for other various sizes. The weight and the length of the stick must be such, as that when tied on, the rocket shall balance on the finger, at a point about 1 inch from the part choked.

ROCKET COMPOSITIONS.—The brilliancy of the rocket depends upon the composition in the cases, and great care is required in the mixture of the ingredients, which should be well dried and carefully sifted through a hair sieve before mixing. For a $\frac{1}{4}$-lb. rocket, to 12 oz. of saltpetre add 6 of charcoal and 4 of sulphur; or for signal rockets the proportions are, saltpetre, 4 lbs.; dogwood charcoal, 1 lb. 12 oz.; sublimed sulphur, 1 lb. Powder separately, and mix with the hand or a wooden spoon. Saltpetre increases the rapidity of the fire, whilst sulphur retards it, and the charcoal emits those volumes of sparks which form the golden train of an ascending rocket. Rockets are primed with mealed powder and spirits of wine.

PYROTECHNIC AND ROCKET STARS.—The stars that are used as decorations to the different species of fireworks are of various kinds, sizes, and shapes, according to the purpose for which they are intended.

The ordinary rocket stars, which are called "brilliant" or "bright," are made in small cubes. Their composition is moistened with gum water, and while moist flattened to the thickness required. It is then scored or cut across with a knife, and allowed to dry. When dry it can be easily broken up into cubes at the places where it was divided by the knife. Tailed stars are also made in the same way and of the same size.

Roman-candle stars are small cylinders of composition made of a size proportioned to that of the case out of which they are to be thrown.

Coloured rocket stars are made by driving the coloured composition, slightly moistened, into small cases, which go under the name of pill-box cases. If the star is to consist of one colour only, these pill-boxes are open at both ends, and a piece of quick-match is placed between the composition and the inside of the pill-box, and allowed to project about $\frac{1}{2}$ an inch beyond each end of it. When fired, these stars burn at both ends at the same time, and so produce a great amount of fire in proportion to their size.

If it is required to make stars consisting of more than one colour (in which case they are called "changeable stars") the pill-boxes are left open at one end only. The composition is thus prevented from burning at more than one of its surfaces at a time. These stars generally contain two colours; the pill-boxes are half-filled with one coloured composition and the remaining space filled with another. These changeable stars burn much longer than the others, and there-

fore produce a more beautiful effect; but being larger they require to be used in larger rockets, the $\frac{1}{2}$ lb. size being the smallest that is adapted for this purpose.

There is another and exceedingly beautiful decoration for rocket-heads which is called golden rain. This is by no means a difficult thing to make. Some small paper cases are made, about 2 inches long and of the size of goosequills; these are filled with a sparkling composition and primed with wetted gunpowder. They are placed, mouth downwards, in the head of the rocket, and arranged in such a manner that they may all be ignited. At the bursting of the rocket they will describe a series of beautiful ringlets of sparkling fire.

Common Brilliant Stars.—Nitre, 16 parts; sulphur, 8; sulphuret of antimony, 4; meal-powder, 3. Let all the ingredients be in as fine a powder as possible; and, having carefully weighed out the quantities, mix them thoroughly. Next, take some weak gum water made by dissolving 2 oz. of gum-arabic in a pint of warm water. Spread the star composition upon a piece of zinc plate or slate, and add to it a little of the gum water at a time, taking care to stir the composition about well till all the moisture is equally diffused. It is not necessary that this composition should be made wet, but only something like brown sugar in moistness, so that it will bind well when pressed together. When this is sufficiently done, roll or press the composition into a flat shape like a thick pancake, and make it as square as possible. Its thickness should be about $\frac{1}{4}$ of an inch. Take a blunt knife spatula, and with it score the composition across both ways, so that it is divided into a number of little cubes.

Tailed Stars.—These stars are not moistened with plain gum water, but with a mixture of gum water and linseed oil. The gum water should be of the strength given above, and should be made quite hot by placing the bottle which contains it in a jug of boiling water. When it is sufficiently hot, to every 8 oz. of gum water add 1 oz. of linseed oil. Shake the bottle till these are thoroughly mixed and no oil can be seen. Use the moistening fluid, while hot, in the same manner as directed above for brilliant stars. The following is the composition for tailed stars:—Nitre, 16 parts; meal-powder, 12; antimony (sulphuret), 8; fine charcoal, $4\frac{1}{2}$; sulphur, 4.

Coloured Stars.—These require considerable care in their preparation, the beauty of their performance depending entirely upon the uniform fineness, the intimate union, and the dryness of their ingredients. The various preparations which enter into their composition should always be kept ready for use in fine dry powder, preserved in well-corked or stoppered bottles. The pill-boxes for coloured stars are made in the following manner:—Procure a piece of straight iron rod, 12 inches long, and from $\frac{3}{8}$ to $\frac{1}{2}$ an inch in size; the usual size for this former is about $\frac{7}{16}$ of an inch. Now cut some cartridge paper into strips about 8 inches wide, and from 9 to 10 inches long; paste these strips all over, and roll them round the iron rod closely and neatly. When this is done, remove the case thus formed from the rod without tearing or breaking it, and set it aside to dry. When dry it will be very hard and stiff. It can then be cut, by means of a very sharp knife, into little lengths of $\frac{1}{2}$ an inch each. These lengths are the open pill-boxes, into which composition is to be rammed for coloured rocket stars. In order to accomplish the filling of these cases with the least amount of trouble, procure a piece of stick, of a convenient length, and of such a size round that it will pass easily into the pill-boxes, and with a short groove cut in the side, sufficient to allow it to pass the quick-match without injuring it. Next take a small piece of quick-match, about $1\frac{1}{2}$ inch long, and pass it through the pill-box in such a manner that it may project beyond each end about $\frac{1}{2}$ an inch. The composition pressed with the stick into these boxes is always slightly moistened; and by this means, when once dry, will not be liable

to be shaken out again. The fluid employed for moistening these coloured compositions is a solution of shellac in methylated spirit of wine. Care must be taken not to make these compositions *wet*. A very slight moistening is sufficient to make them bind well when pressed into their cases.

Crimson Stars.—1. Chlorate of potash, 24 parts; nitrate of strontia, 32; calomel, 12; sulphur, 6; shellac in fine powder, 6; sulphide of copper, 2; fine charcoal, 2. 2. Chlorate of potash, 12 parts; nitrate of strontia, 20; sulphur, 11; charcoal, 2; antimony, 2; mastic, 1. 3. Nitrate of strontia, 72; sulphur, 20; gunpowder, 6; coal-dust, 2.

Rose-coloured Stars.—Chlorate of potash, 20 parts; carbonate of strontia, 8; calomel, 10; shellac, 2; sulphur, 3; fine charcoal, 1. The advantage of this composition is that it is not at all liable to suffer from damp in winter. The carbonate of strontia is a salt not absorbent of moisture like the nitrate, and is, moreover, always to be had in a state of fine powder.

Green Stars.—1. Chlorate of potash, 20 parts; nitrate of baryta, 40; calomel, 10; sulphur, 8; shellac, 3; fine charcoal, 1; fused sulphide of copper, 1. 2. Nitrate of baryta, 42 parts; realgar, 2; sulphur, 8; lampblack, 1. 3. Chlorate of potash, 28 parts; nitrate of baryta, 12; sulphur, 15; mastic, 1.

Pale Rose-coloured Stars.—Nitrate of strontia, 8 parts; chlorate of potash, 4; sulphur, 3; sulphuret of antimony, 2. Take especial care that the nitrate of strontia used in this formula is very dry.

Pale Green Stars.—Nitrate of baryta, 16 parts; chlorate of potash, 8; sulphur, 6; antimony, 3.

Yellow Stars.—1. Chlorate of potash, 20 parts; bicarbonate of soda, 10; sulphur, 5; mastic, 1. 2. Chlorate of potash, 30; dried soda, 12; sulphur, 8.

Golden Yellow Stars.—Chlorate of potash, 20 parts; nitrate of baryta, 30; oxalate of soda, 15; sulphur, 8; shellac, 4. If it is thought advisable to give the stars made from this formula a tailed appearance, add one part of fine charcoal. The composition is to be moistened with the shellac solution. The stars form a beautiful contrast with those of an intense blue.

Blue Stars.—1. Chlorate of potash, 8 parts; sulphide of copper, 6; Chertier's copper, 5; sulphur, 4. 2. Chlorate of potash, 12 parts; Chertier's copper, 6; sulphur, 4; calomel, 1. 3. Chlorate of potash, 16 parts; Chertier's copper, 12; calomel, 8; stearine, 2; sulphur, 2; shellac, 1. This gives a most intense blue. 4. Chlorate of potash, 20 parts; carbonate of copper, 14; sulphur, 12; mastic, 1. 5. Nitre, 12 parts; sulphuret of antimony, 2; sulphur, 4; lampblack, 2. All these compositions should be moistened with gum water, and in No. 3 the stearine employed must be in fine powder.

Violet Stars.—Chlorate of potash, 9 parts; nitrate of strontia, 4; sulphur, 6; carbonate of copper, 1; calomel, 1; mastic, 1.

White Stars. — Saltpetre, 9 parts sulphur, 3; antimony, 2.

To prepare Chertier's Copper.—Take any quantity of common sulphate of copper, or blue vitriol, and dissolve it in as little water as possible; then take an equal quantity by weight of chlorate of potash and also dissolve it in as little water as will hold it in solution. Mix these two solutions, and boil them gently over a clear fire until the moisture is nearly evaporated; then dry the green precipitate that remains by a gentle heat. When dry treat it with strong liquor ammoniæ till it changes to a deep blue colour; then let it dry very gradually in a warm place. If this operation be properly performed you will have a fine, very light blue powder, which is Chertier's copper.

To prepare Nitrate of Strontia.—Procure a common earthenware pipkin, or a glazed iron frying-pan of a convenient size. Into this place nitrate of strontia in rough crystals. 1 or 2 lbs. will be sufficient to prepare at a time. Place the vessel on a clear fire, but do not make it too hot. Now boil, or rather stew, the crystals in their own water of crystallization. The heat will soon cause them to run into a thick pulpy mass.

When in this state, they must be constantly stirred, or upon the evaporation of the moisture they will reassume a crystalline form. Continue then to stir it with a stick or flat piece of wood until the moisture is driven off by the heat, and the salt remains in the condition of a white dry sand. No strontia can be used for coloured stars or fires unprepared, and this operation is proper also for the preparation of the nitrate of baryta.

GOLDEN RAIN. — Golden rains are made in the following manner:—Procure a piece of brass rod, the diameter of which is $\frac{5}{16}$ of an inch, or rather less. The length of the former may be from 6 to 8 inches. Cut thin brown paper into short strips, about 2 inches wide, and long enough, when wrapped round the former, to make a case whose external diameter should be $\frac{3}{4}$ of an inch, or rather more. The former should have a small cup-shaped hollow cut in one of its ends, into which the paper may be turned, to form a closed end to the cases. Paste the strips of paper all over, and also rub some paste on the former; then roll the paper round the former, and draw it out so as to leave its cupped end $\frac{1}{2}$ of an inch inside one of the ends of the case. Pinch in the paper that projects beyond the former, and drive it down with a tap upon the pasting slab, so that the twisted end is pressed into the cup of the former. By this means a neat and secure end is obtained for the cases, which may be dipped afterwards into warm size or glue. If a little red-lead is mixed with this size, it will solidify much more rapidly. This dipping the ends of the cases into size should not be done until they are dry from the paste. For filling the cases a tin funnel is used that will exactly fit into the mouth of golden-rain cases. The composition employed for filling the cases is the following:—1. Meal-powder, 6 parts; nitre, 1; fine charcoal, 2. 2. meal-powder, 8 parts; fine charcoal, 3. 3. Saltpetre, 1 lb.; meal-powder, 4 oz.; sulphur, 4 oz.; brass dust, 1 oz.; sawdust, $2\frac{1}{4}$ oz.; glass dust, 6 drs. When the case is charged, the funnel must be removed, and the space that was occupied by its nozzle filled with gunpowder or meal-powder moistened with gum water. This will prevent the composition from being shaken out of the cases and at the same time forms the best method of priming them. Take care that this paste is pressed well into the mouth of the cases, and fills them.

Silver Rain. — 1. Saltpetre, 4 oz.; sulphur, mealed powder, and antimony, each 2 oz.; sal prunella, $\frac{1}{2}$ oz. 2. Saltpetre, 8 oz.; sulphur, 2 oz.; charcoal, 4 oz. 3. Saltpetre, 1 lb.; antimony, 6 oz.; sulphur, 4 oz. 4. Saltpetre, 4 oz.; sulphur, 1 oz.; powder, 2 oz.; steel dust, $\frac{3}{4}$ oz. Used in similar cases and treated in the same way as *golden rain.*

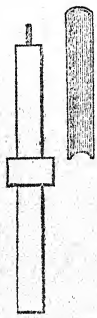
PORTFIRES. — The portfires used for firing rockets and fireworks are generally made in the following manner:—The former for this purpose should be of brass, and not less than $\frac{1}{4}$ of an inch in diameter, and the wire for filling them not less than $\frac{1}{8}$ of an inch. Portfire cases are usually made very thin, but prepared in precisely the same manner as that described for golden rains, and are also primed in the same way. The following are the compositions usually employed for portfires. 1. Nitre, 6 parts; sulphur, 2; meal-powder, 1. 2. Saltpetre, 2 lbs.; sulphur, 3 lbs.; antimony, 1 lb. 3. Saltpetre, $3\frac{1}{2}$ lbs.; sulphur, $2\frac{1}{2}$ lbs.; meal-powder, 1 lb.; antimony, $\frac{1}{2}$ lb.; glass dust, 4 oz.; brass dust, 1 oz.

ROMAN CANDLES.—In the manufacture of these fireworks the following important points must be observed, namely, to have a composition to burn in the intervals between the stars, which will throw a jet of fire uniformly good throughout, to have stars of tolerably rapid combustion, otherwise they will not be ignited before they are blown into the air, and to have the charges of powder for blowing the stars regulated to a great nicety. The former for the cases must be $\frac{5}{8}$ of an inch in diameter, and 18 inches long. The cases require rather a large amount of paper and imperial board for their manufacture, but otherwise they are made similar to rocket cases.

Roman-candle Stars. — The brilliant stars may be made of the same composi-

tion as that given for rocket stars of that kind. If, however, a whiter star is required, use the following:—Nitre, 48 parts; sulphur, 10; regulus of antimony, 8; realgar, 6; red-lead, 4; shellac, 1. Yellow Roman-candle stars may be made from the same formula as that given for yellow-rocket stars. Green Roman-candle stars may be made from the formulas given for rocket stars; but there is also another formula, which produces a rather deeper tint, but is hardly rapid enough in combustion for rocket stars. It is the following:—Nitrate of baryta, 40 parts; chlorate of potash, 20; calomel, 12; sulphur 12; fine shellac, 4; fine charcoal, 1. The formulas for crimson, rose, blue, and purple Roman-candle stars are the same as given for rocket stars. In order to make the stars, moisten the compositions very slightly. The mould in which these stars are shaped is a brass tube, Fig. 21, of a size proportioned to the size of the Roman-candle case, and is generally about $\frac{1}{16}$ of an inch smaller in its inner diameter than the case. The drift with which the composition is pressed into the tube, is made of boxwood or metal, and fits easily into the tubular mould. At one of its ends there is a wire point. Place the end having the point in the mould as far as it will go. It will leave a space at the end of the mould unoccupied by the drift. Press this empty end of the tube into the slightly-moistened composition until it is filled by it, so that the drift, being driven down upon the composition, will compress it into a firm cylindrical mass, into the centre of which the wire point projects. When the star is thus formed in the mould the drift must be withdrawn, reversed, its long plain end inserted, and the star pushed out. The object of making the star hollow is that it may dry and harden perfectly in its centre, and also for the priming of the star, which is effected by placing a little piece of quick-match into the hole in the star, and allow it to project about $\frac{1}{4}$ of an inch above. By this means even slowly-combustible stars are ignited, and almost every chance of failure is avoided. This priming, however, should not be done until the stars are to be put into the cases—at all events, till they are perfectly dry.

Fig. 21.



Composition for Roman Candles.—1. Nitre, 18 parts; sulphur, 6; fine charcoal, 7; meal-powder, 4. 2. Nitre, 16 parts; meal-powder, 8; fine charcoal, 6; sulphur, 6. 3. Nitre, 16 parts; meal-powder, 11; sulphur, 6; antimony, 4. The next thing is to fill the case. Before filling it introduce a little clay to the bottom of the case, thus forming a better and firmer bottom. This being done properly, put in a little coarse powder, and over this a small piece of paper, to prevent the composition mixing with the powder; then ram down as much composition as will fill the case one-sixth of its height; over this put a small piece of paper covering about two-thirds of the diameter, then a little corn powder, and upon that a ball, observing that the ball is rather smaller than the diameter of the case. Over this first ball more of the composition must be put and rammed lightly down to prevent breaking the ball, till the case is one-third full; then a piece of paper, a little powder, and then another ball as before, till the case is filled with balls and composition, taking care to place composition above the highest ball. When the case is thus filled, cap it with touchpaper by pasting it round the orifice, and a little priming of powder being added the work is complete.

TOUCHPAPER. — Obtain some thin blue paper—not so thin as tissue paper, but thinner than the ordinary blue paper used by storekeepers; brush or sponge this over with or dip it into a weak solution of saltpetre, and when well saturated dry for use. Touchpaper should be cut into slips, placed once round the mouth of the firework, and twisted into a point.

QUICK-MATCH.—Make a thick paste of gunpowder and hot water, with a

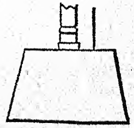
small quantity of gum in it. Take about four strands of cotton, such as is sold in balls and used for making the wicks of lamps, steep this in the solution of nitre used for making touch-paper, and wring it as dry as possible; then rub it well in the gunpowder paste till it is thoroughly covered with it. One end of the cotton may be passed through a small funnel, whose mouth is not more than $\frac{1}{8}$ of an inch in width. By this means, if the whole length of the cotton is drawn through it, the superfluous paste will be removed, and the match will be of a nice round form. Hang it out of doors on a dry day, and when it is nearly dry coil it upon a tray or paper, and dust it over with meal-powder. In winter it will not be sufficiently dry for use under a week. When thoroughly dry it should be stiff and hard, and the less it is bent or doubled the better. To use this match for connecting the mouths of different fireworks, or clothing them as it is termed, make some long paper tubes round a wire former which has a diameter of not less than $\frac{3}{16}$ of an inch. These pipes are threaded on the match, and have a piece cut away at their side wherever they are inserted into the mouth of a case, in order that the match may be laid bare and convey its fire to the priming of the cases.

Gerbes and Jets of Brilliant, Chinese, and Common Fires.—These are certainly among the most beautiful and effective pieces to be met with in the whole range of pyrotechny. They have one great advantage—that there is no limit to the modes of combination or arrangement in which these pieces may be effectively employed. By means of them any such things as the following can be made:—Fountains of any size or design, cascades, brilliant suns, either fixed or revolving, bouquets of Chinese fire, spread eagle, trees of silver flowers, and a thousand other devices. Their compositions, to produce the desired effect, must be made as shortly as possible before it is intended to fire them, as iron and steel filings are a principal ingredient in their composition. Many attempts have been made to secure these metallic ingredients from corrosion. A coating of any kind is tolerably certain either to rob the spark which each particle of metal should produce of its brilliancy, or to render the composition during combustion very smoky, and so impair the intended effect. The most successful plan is the following:—A weak solution of asphalte in naphtha is made, and the filings or borings are stirred about in this. When it is thought that they are thoroughly covered with it, the solution is poured off, and the filings spread out upon paper to dry. But still the best way is to prepare the compositions as short a time as possible before they are to be fired. The cases should be made like rocket cases, and choked while wet, only it must be remembered that their aperture may be almost choked up, because when it has been reopened by the point over which they are loaded, it must not be more than $\frac{1}{8}$ of the interior diameter of the case in size.

Red Chinese Fire.—1. Meal-powder, 16 parts; nitre, 16; sulphur, 4; charcoal, 4; iron borings, 14. 2. Meal-powder, 16 parts; sulphur, 3; charcoal, 3; iron borings, 7. 3. Meal-powder, 8 parts; nitre, 16; sulphur, 3; charcoal, 3; iron borings, 8. 4. Meal-powder, 16 parts; nitre, 8; sulphur, 4; charcoal, 3; iron borings, 7.

White Chinese Fire.—1. Meal-powder, 16 parts; nitre, 6; sulphur, 3; iron borings, 10. 2. Meal-powder, 16 parts; nitre, 4; sulphur, 2; iron borings, 6. 3. Meal-powder, 16 parts; iron borings, 5. For filling the cases nipples of various sizes are employed, made preferably of metal. The case must now be pressed over the point of the nipple, Fig. 22, and by this means its aperture will be made of the proper size. It will be found very convenient to have a ring of iron fixed into your block, through which the case must be passed, which will steady it and keep it in a perpendicular position while being filled. Now drive in the composition,

Fig. 22.



a ladleful at a time, and after putting in each ladleful, give the drift twelve blows with the mallet. Fill the cases till there remains a space of 2 inches only unoccupied at the end. Into this end put a gun charge and a half of gunpowder. Then with a bradawl separate one or two of the inner folds of the paper of the case, and turn these down on the top of the powder. For filling in the ends of the cases:—Melt in an earthen pipkin a mixture of 2 parts of common resin and 1 of wax. This may be poured into the ends of the cases upon the paper that has been turned down. It will harden in a few minutes, and will be found to ensure a good report from the powder. To prime these cases:—This is an operation requiring some care, although it may be performed in a very simple manner. If the point of the nipple is not too long, all that is needed is to press into the mouth of the case some meal-powder paste; but if a cavity has been left in the composition, this must be filled up before priming, or the case will inevitably burst. It is an excellent plan to take for the first ladleful, not any of the compositions for Chinese fire, but a ladleful of some slower fire containing no iron borings, such as a mixture consisting of nitre, 6 parts; sulphur, 1; charcoal, 1. These gerbes or jets are exhibited, when finished, by being attached to strong frames of wood or metal, arranged in such a manner as the exhibitor may wish, to produce any desired effect. The mouths of the cases are connected by means of leaders or quick-match.

Brilliant Fire.—The cases employed for brilliant fire need not be so large as those employed for Chinese fire, but observe the same rules in filling these cases. 1. Meal-powder, 4 parts; bright steel filings, 1. 2. Meal-powder, 16 parts; nitre, 8; sulphur, 3; fine charcoal, 3; bright steel filings, 10. Neither of these compositions should on any account be mixed before their preparation is absolutely necessary, for their whole beauty depends upon the brightness of the filings at the time of firing.

Common and Sparkling Fires.—1. Meal-powder, 4 parts; charcoal, 1. 2. Meal-powder, 16 parts; nitre, 8; sulphur, 4; charcoal, 4. 3. Meal-powder, 16 parts; very fine glass dust, 5. 4. Meal-powder, 8 parts; very finely powdered porcelain, 3. These fires can be arranged very effectively as stars, suns, &c. For instance, provide a circular disk of hard wood, 6 inches in diameter, and 1 inch thick. Nail to this five spokes of wood at equal distances from one another, and 15 inches long. Nail also to the back of the central disk a strip of wood about 2 feet long, 2 inches wide, and $\frac{3}{4}$ of an inch thick. By means of this you can screw the whole piece conveniently to your firing post. On each of the five spokes tie a case of brilliant fire, reported at its end, and connect the mouths of these with quick-match.

LANCES.—Lances are used in making up devices, such as *names*, mottoes, wreaths, and so on. They consist of small cases, generally made about $\frac{3}{16}$ of an inch in diameter, that is, round a piece of glass or brass rod or tube of that size; tubes are always best for these small formers. The cases are about 2 or $2\frac{1}{2}$ inches long, with one end pinched or turned in. Two rounds of thin demy or double-crown white paper, pasted, will give sufficient thickness and substance for the case. The cases, when dry, are to be filled with either of the following compositions in the same way as golden rain:—

Compositions for Lances. White.—1. Nitre, 16 parts; sulphur, 8; meal-powder, 6. 2. Nitre, 16 parts; sulphur, 4; meal-powder, 6. 3. Nitre, 12 parts; sulphur, 4; sulphide of antimony, 3. 4. Nitre, 72 parts; sulphur, 18; regulus of antimony, 33; realgar, 1; shellac, 1. 5. Nitre, 96 parts; sulphur, 24; regulus of antimony, 48; realgar, 6; shellac, 1. These for the most part give a bluish white flame, and when employed in cases of the size mentioned above, burn slowly, and will last as long as this species o firework is required to last.

Yellow.—1. Chlor. of potash, 72 parts; oxal. soda, 60; stearine, 6; sulphur, 6.

2. Chlor. pot., 40 parts; oxal. soda, 16; shellac, 8; stearine, 3.

Green.—1. Chlor. pot., 60 parts; nitr. baryta, 41; calomel, 49; powdered sugar, 30; shellac, 1. 2. Chlor. pot., 63 parts; nitr. baryta, 50; calomel, 50; sugar, 32; shellac, 1.

Emerald Green.—1. Chlorate of baryta, 18 parts; calomel, 7; very fine shellac, 3. 2. Chlorate of baryta, 24 parts; stearine, 3; very fine sugar, 1.

Red Lances.—1. Chlor. pot., 13 parts; nitr. strontia, 10; calomel, 8; shellac, 3; dextrine, 1; Chertier's copper, 1. 2. Chlor. pot., 12 parts; nitr. strontia, 12; calomel, 6; shellac, 4; Chertier's copper, 1; fine charcoal, 1.

Rose-coloured Lances.—Chlorate of potash, 24 parts; sulphur, 2; stearine, 3; oxalate of strontia, 4. This composition will remain good for any length of time.

Blue Lances.—1. Chlorate of potash, 12 parts; Chertier's copper, 6; sulphur, 4; calomel, 1. 2. Chlorate of potash, 32 parts; Chertier's copper, 12; calomel, 40; sugar, 25. 3. Chlorate of potash, 6 parts; Chertier's copper, 1; calomel, 5; sugar, 4.

Violet.—Chlorate of potash, 26 parts; calomel, 24; carbonate strontia, 4; Chertier's copper, 3; sugar, 14.

Lilac.—Chlorate of potash, 12 parts; prepared chalk, 4; sulphur, 5; calomel, 3; sulphide of copper, 10. Sugar for pyrotechnic compositions must be kept in a closely-corked or stoppered bottle. It should be reduced to powder in a very dry mortar, and then sifted through very fine muslin.

To exhibit lances procure a board of sufficient size for the design, or make a wooden framework of the shape that is required. Sketch the design upon one side of the board, or, larger than a board will allow, make a plain rough framework describing the letters. When this is done, decide upon the distance at which to place the lances one from another. This distance is generally about 2 inches, but no exact rule can be laid down, for much depends upon the kind of design, and upon its size. Upon the outlines of the sketch make little pencil circles wherever it is intended to place a lance; and, as far as it is possible, arrange that the lances shall be equidistant one from another. Now with a centre-bit, or, what is better, a pin-bit, bore a hole about a $\frac{1}{4}$ of an inch deep where the circles are pencilled. These holes must be of such a size that the closed ends of the lances will fit easily into them. Get either some glue or some of the mixture of size and red-lead, and when it is liquid, dip into it the closed end of each of the lances. Enough of the mixture will adhere to the lances to allow of their being secured firmly in the holes that have been bored. In a very short time all will be hard and dry, and you will then have a series of lances projecting at right angles with your board or framework, each having its mouth primed, and all being the same length. The only thing that remains now to be done is to clothe these primed mouths with quick-match. This is by no means difficult, but requires a certain amount of patience. Take a length of match in its case, and, having exposed one end of the black match itself, put a small pin through it into the priming of one of the lances. This will fasten it down, and at the same time will ensure ignition. Then lead the quick-match on to the next lance, cutting away with scissors a piece of the under side of its case, to allow the match in passing to touch its priming. Put a pin through the match into the priming of this lance also, and so on till all are clothed. If more of the casing of the match has been cut away than is necessary, it will be well to paste small strips of paper wherever this has happened, as any exposure of the black match will endanger the piece, rendering it liable to ignition from the sparks of other fireworks.

COLOURED LIGHTS.—Their preparation is exceedingly simple. They are generally made in two sizes only; these are the 2-oz. and the 1-oz. sizes. The cases are made of cartridge or foolscap paper, and are about 2 inches long for the 2-oz. size and $1\frac{3}{4}$ inch for the 1-oz. size. Used-up copy-books furnish excellent paper for making these coloured-light cases. Three or four

rounds of the paper will give ample thickness for the case. The paper should be pasted all the way along the strips. When the cases are thoroughly dry, ram into the bottom of them some dry powdered clay; this will make a close end, and will also furnish an incombustible part by which the case may be tied or fastened to its place.

White Lights for Decoration. — 1. Nitre, 4 parts; sulphur, 1; sulphide of antimony, 1. 2. Nitre, 4 parts; sulphur, 1; meal-powder, 1. These will give the ordinary bluish light, and compositions made from them will remain good for any length of time.

Yellow Lights may be made from the formulas given under the head of Lances.

Green Lights.—Nitrate of baryta, 80 parts; chlorate of potash, 32; sulphur, 24; calomel, 16; fine charcoal, 3; shellac, 2.

Red Lights.—1. Chlorate of potash, 32 parts; nitrate of strontia, 48; calomel, 20; shellac, 12; Chertier's copper, 4; fine charcoal, 1. 2. Chlorate of potash, 84 parts; nitrate of strontia, 80; calomel, 51; dextrine, 22; shellac, 18; Chertier's copper, 4.

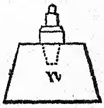
Purple.—1. Chlorate of potash, 28 parts; Chertier's copper, 28; calomel, 13; shellac, 8; stearine, 1. 2. Chlorate of potash, 40 parts; calomel, 28; Chertier's copper, 28; dextrine, 10; stearine, 3. 3. Chlorate of potash, 26 parts; Chertier's copper, 24; calomel, 14; shellac, 7.

TOURBILLONS. — The tourbillon is a species of firework very ingeniously contrived to represent a spiral column of fire. Its performance is of short duration, but while it lasts it produces a very striking effect. A tourbillon consists of a stout case filled with a strong sparkling composition, and closed very tightly at both ends. In this case are bored four holes, at which the fire is to find vent. Two of these holes are made underneath the case; from these the fire issues in a downward direction, and gives the piece the power of ascending perpendicularly. The outer two holes are made in opposite sides of the case near each end; the fire issuing from these causes the cases to revolve in a horizontal direction while it is ascending. The cases are made as for rockets, and should be about 8 inches in length, and ¾ of an inch in their bore. Their external diameter will be found to be about 1⅛ inch.

Plain Tourbillons. — Nitre, 8 parts; meal-powder, 16; sulphur, 4; charcoal, 4.

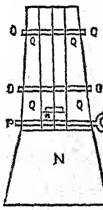
Brilliant Tourbillons. — Meal-powder, 16 parts; nitre, 8; sulphur, 3 to 4; fine charcoal, 3; steel filings, 6. Tourbillon cases are filled by means of an apparatus which consists of a block of wood, Figs. 23, 24, provided with a settle, *n*, on which one end of the tourbillon case is placed, and over which the composition is rammed. There is a wooden mould for enclosing the case and supporting it tightly and firmly while the operation of ramming is being performed.

FIG. 23.



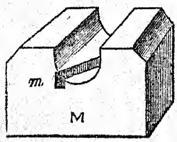
This mould Q, Q, Fig. 24, consists of a hollow cylinder of wood pierced throughout, and of such a size in its bore as will just admit the tourbillon case. The mould is divided longitudinally in halves, and these halves are kept together by means of iron rings, O O O O, which encircle the whole. P P is a pin to pass through cylinder and settle to connect them. In order to fill the cases, squeeze one end of one of them over the projecting piece at the top of the settle. Fit on the two halves of the cylindrical mould, drive down the iron rings until they are tight, and put in the pin which secures the cylinder to the block and settle. First put into the tourbillon case as much clay as will, when rammed very hard, occupy ⅜ of an inch in the length of the case. The settle projects into the case about ⅛ of an inch, and thus ½ an inch at each end of the case is left for the purpose of ensuring a very firm ending,

FIG. 24.



which cannot be blown out by the combustion of the composition. When the clay has been rammed in as tightly as possible, drive in the composition, a ladleful at a time, as uniformly as possible, until only $\frac{1}{2}$ an inch at the upper end of the case is unoccupied by it. Into this vacant space drive the same quantity of clay that was put into the lower end, and be sure that it is rammed in very firmly. When this is done, open your penknife, and lay its blade on the table, back downwards and edge upwards. Place the filled tourbillon case across the edge of the knife, and find the exact central point at which it balances on it, and mark that point by making a hole there with a small bradawl. Now, having found the centre of its balance, next mark the places at which the holes are to be made, and by far the best way is to use a shape made of zinc or tin, such as is shown Fig. 26. This piece of sheet metal, when bent into the form of a trough of such a size as to fit tightly round the tourbillon case, will give the true position of the holes. In using it put the filled tourbillon case into it, and make pencil marks through the holes that correspond to those drawn in the Fig. 26, and you will then have got over the entire difficulty. In the middle of the scale is one small hole. This hole is to come exactly over the mark made with the bradawl at the balancing point, and if this be done all the rest must come right. Having thus marked the position of the holes, the next thing is to bore them. This is best effected by means of a bradawl driven by a mallet, the tourbillon during the operation being laid upon a small block of wood, M, with a groove cut in it, as m, Fig. 25. The holes should be as nearly as possible $\frac{3}{16}$ of an inch in size. It is easier to drive the bradawl with a mallet than to work it in with the hand. It must not be driven in farther than necessary, the

Fig. 25.



object being merely to make a clear hole through. If a block is 2 inches square or rather more it will be quite large enough. The block will be found very useful afterwards. The two extreme holes, which are on opposite sides of the case, are made at the ends of the composition; the fire issuing from these gives the tourbillon a horizontal revolution round its centre of balance. The two inner holes, which are on the under side of the case, should be the same distance from one another that they are from the extreme holes; the fire issuing from these gives the tourbillon its ascending power. We have now to connect all these holes with quick-match, in order that the composition may take fire at all the four points simultaneously; and unless this is attended to with care, it will not only cause the tourbillon to fire irregularly, but entirely destroy its effect. Begin at one of the under holes, those marked F in Fig. 26, and press into it the end of a piece of uncased

Fig. 26.

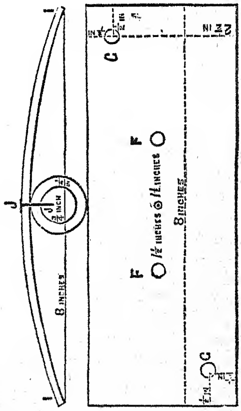


Fig. 27.

quick-match, taking care that the match reaches the composition. Then carry the match on to the nearest side hole, and press it into it. Carry on the quick-match over the upper side of the tourbillon to the side hole at the other end of the case, and press it in there; and,

lastly, carry it on to the remaining under hole, and press it into it. Having completed this operation, cut some strips of thin paper, about 1 in. wide, paste them well over, and cover the quick-match with them, holes and all. A very little practice will enable one to adapt this pasted paper very neatly. The tourbillon, if now ignited, will be sure to go somewhere, but in order to regulate its flight we must adjust a stick to it, which shall have the effect of keeping its under side downwards, and so of compelling it to move upwards perpendicularly. This stick is usually made of beech, 8 inches long, about $\frac{1}{8}$ inch thick, and of a curved shape, in the manner represented at I I in Fig. 26. There is a small hole in their centre through which a flat-headed nail is driven into the tourbillon at its balance point. The stick must, of course, lie at right angles with the case in the manner represented at R, Fig. 28. It is a very good plan to put a drop or two of glue

FIG. 28.

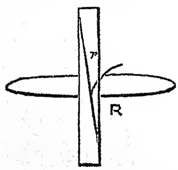
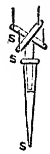


FIG. 29.



at the point where the stick touches the case, as it will then be prevented from shifting its position. In driving the nail through the stick into the tourbillon, make use of the block represented at M, having previously cut at the bottom of its rounded groove another small groove diagonally, so that when the tourbillon is lying upside down in the large groove, for the purpose of having the nail driven into it, the quick-match that extends across it may lie in the smaller groove, and may not be injured by being crushed, as would otherwise be the case. The nails used should be about $\frac{3}{4}$ of an inch long, and should have a smooth, flat head. To fire the tourbillon, place it stick downwards on a level board, and see that it spins easily and freely on the head of the nail. Then with a portfire burn through the quick-match in the middle on the upper side. The tourbillon will make a few revolutions on the board before it begins to rise.

Reference to Figs. 24 to 29.—M, block to receive the tourbillon while it is being bored. *m*, groove in it to receive the quick-match. N, block, with settle (*n*) over which tourbillons are rammed. Q Q Q Q, wooden cylinder to enclose tourbillon case. O O O O, iron rings to tighten cylinder. P P, pin to pass through cylinder and settle to connect them. R, tourbillon complete, with stick attached. S, revolving cradle from which tourbillons are fired. *s s*, iron spike, with tubular top, in which the cradle revolves.

DRAWING-ROOM FIREWORKS.—*Lightening Paper.*—Dry 1000 grains of pure nitre at a moderate heat, place it in a dry retort, pour on it 10 drachms by measure of strong sulphuric acid, and distil until 6 drachms of nitric acid have passed over into the receiver. Dry some thin unsized paper, such as filter paper, and weigh out 60 grains of it. Mix 5 measured drachms of the nitric acid with an equal volume of strong sulphuric acid in a small glass vessel; allow the mixture to cool; immerse the paper, pressing it down with a glass rod, cover the vessel with a glass plate, and set it aside for 15 or 20 minutes. Lift the paper out with a glass rod, throw it into a bucket of water, and wash it thoroughly in a stream of water till it no longer tastes acid or reddens blue litmus paper. Dry it by exposure to the air, or at a very gentle heat.

Japanese Matches. — Lampblack, 5; sulphur, 11; gunpowder from 26 to 30 parts, this last proportion varying with the quality of the powder. Grind very fine, and make the material into a paste with alcohol; form it into dice about $\frac{1}{4}$ of an inch square, with a knife or spatula let them dry rather gradually on a warm mantelpiece, not too near a fire. When dry, fix one of the little squares into a small cleft made at the end of a lavender stalk, or, what is

better, the solid straw-like material of which housemaids' carpet-brooms are made. Light the material at a candle, hold the stem downward. After the first blazing off, a ball of molten lava will form, from which the curious coruscations will soon appear.

QUICK-MATCH.—Quick-match is made of cotton lamp-wick thread, soaked for an hour or two in a mixture of gunpowder, 1½ lb., and gum water, made by dissolving 2 oz. of gum-arabic in 1 pint of water, into which the gunpowder should be beaten up till dissolved. The cotton may be 3, 4, or more strands in thickness, and should be wound off out of the mixture, passed through a funnel pipe to make it even, and dried on a frame. It must be enclosed in paper tubes for use, as it will not burn with the necessary rapidity if not covered.

Another method is by coating lamp-cotton as thickly as possible with meal-powder, rendered adhesive by mixture of thick gum-arabic, and covered by two strips of paper wound round it spirally, one over the other in opposite directions, the outer one being pasted to the inner.

FIRE BALLOONS. — The material for making a small balloon should be a fine, thin, close-textured tissue paper. Having determined that the balloon shall consist of a specific number of gores, or sections, say 34 or 16, a pattern for cutting them by should be made of pasteboard, or some tolerably hard substance. Suppose the entire height of the balloon, without its appendages, is to be 3 feet, and the number of gores 32, an elegant shape will be got by making the pattern 1 inch wide at one end, 3 inches at the other, and 8 inches at its broadest part, which should be at one-third of its length, if the balloon is intended to have a pear-like figure. Varnish the gores with the ordinary boiled oil, and hang them up singly on lines till perfectly dry. They are next to be put together, which may be done with gum water or clean thin paste. After pasting or gumming about ½ an inch of one of the gores, lay the edge of another about midway across the part pasted, and then double over about ¼ of an inch of it, dabbing it lightly from end to end with a clean cloth, to ensure its holding securely. Two of the gores being thus united, unite two others in like manner, and so on, until, if there were 32 gores in all, the number is reduced to 16. In like manner proceed till the number is eight, then four, and then two; hanging the sections up at every pasting, so that they may get thoroughly dry whilst proceeding. The two halves are last of all to be connected in the same way; and this part of the undertaking is then completed. A circle of wire, about 6 inches in diameter, should be worked into the bottom of it, to keep the fabric of the balloon at a sufficient distance from the flame of the spirit. Another wire may be fixed across this circle to hold a piece of sponge, which should be immersed in spirits of wine. A smouldering piece of brown paper held underneath the aperture will in a few minutes put the balloon in an ascending condition. Having thus inflated the balloon, ignite the piece of sponge, and let it rise. When it is intended to inflate the balloon with hydrogen or coal gas, the latter apparatus is not needed; but a light car, or any other ornament proportioned to the ascending power of the balloon, may be appended to it, which will have the effect of maintaining it in the right position, and also of keeping it longer in sight than would otherwise be the case.

SALTPETRE FROM DAMAGED GUNPOWDER. — Dissolve the powder in warm water, filter the solution through fine linen bags, and then evaporate the water by boiling it, until the solution is of sufficient strength to crystallize.

SERPENTS, OR SQUIBS. — 1. Mealed powder, 1 lb. 8 oz.; charcoal, 4 oz.; sulphur, 1 oz.; saltpetre, 3 oz. 2. Mealed powder, 1 lb.; charcoal, 1 oz.; saltpetre, 1¾ oz.; steel filings, 1 oz. The case is made by rolling cartridge paper in slips of 6 or 8 inches in breadth round a former, and pasting down the last fold, for serpents. The case, having been choked at one end, is filled by inserting a funnel into the case, filling the funnel with composition, and gently moving a rod or ram-

mer up and down the funnel-pipe, the rod being introduced before the composition. A piece of touchpaper is fastened to the end. For squibs, before filling the case, ram in hard a thimbleful of coarse gunpowder.

SHOWERS OF FIRE.—*Chinese Fire.*—Mealed powder, 1 lb.; sulphur, 2 oz.; iron filings, 5 oz. *Ancient Fire.*—Mealed powder, 1 lb.; charcoal, 2 oz. To form a shower of fire, mould small paper cases on a rod, $\frac{2}{10}$ of an inch in diameter, and $2\frac{1}{2}$ inches in length. They must not be choked, as it will be sufficient to twist the end of the case, and having put the rod into it, beat it to make it assume its form. When the cases are filled, which is done by immersing them in the composition, fold down the other end, and then apply a match. They must be fixed on a frame with leaders, to be fired simultaneously.

PIN, OR CATHERINE, WHEELS.—Mealed powder, 12 oz.; saltpetre, 3 oz.; sulphur, $1\frac{1}{2}$ oz. The pipe or case is made on a long wire former, about $\frac{3}{16}$ of an inch in diameter, into which the composition is poured through a funnel, and shaken down. The case is then rolled round a small circle of wood about 1 inch in diameter, and not more than $\frac{1}{2}$ an inch thick, with a hole through the centre of it for a nail, or pin. One end of the case is to be pasted round the wood, and each half turn of it secured with sealing wax, or a strip of paper pasted across the wheel. The end is then primed.

CRACKERS.—The case is made of cartridge paper, the dimensions required being 15 inches by $3\frac{1}{2}$ inches. First fold down one edge, about $\frac{5}{8}$ of an inch broad, then turn down the double edge about $\frac{1}{4}$ of an inch, and bend back the single edge over the double fold, so as to form within a channel, which is to be filled with mealed powder, not ground very fine; the powder is then to be covered by the folds on each side, and the whole is to be pressed by a flat ruler; and the part containing the powder is to be folded into the remainder of the paper, every fold being pressed down. The cracker is then doubled backwards and forwards in folds about $2\frac{1}{4}$ inches, which are pressed quite close, and a piece of twine is passed twice round the middle across the folds, and the joinings secured by causing the twine to take a turn round the middle at each fold successively; one of the ends of the folds may be doubled short under, which will produce an extra report; the other must project a little beyond the rest for the purpose of being primed.

COLOURED FIRES.—In the preparation of coloured fires the utmost care should be taken to have the component parts of the mixtures well triturated apart from each other, passed through fine sieves, and kept separately in stoppered bottles. They do not improve by keeping, and therefore should be used as soon as possible after mixing. The proper amount of each ingredient being parcelled out and placed on a sheet of glass or paper, the whole is carefully mixed with a light hand by means of a bone or wooden knife, a common paper knife for instance. Chlorate of potassa must be treated with especial caution, as it is very liable to explosion from friction whilst in contact with combustible matter.

Blue Fire.—1. Sulphur, sulphate of potassa, and ammonio-sulphate of copper, of each, 15 parts; nitre, 27; chlorate of potassa, 28. For theatrical illuminations. 2. Metallic antimony, 1 part; sulphur, 2; nitre, 5. 3. Sulphate of copper, 7 parts; sulphur, 24; chlorate of potassa, 69.

Crimson Fire.—Chlorate of potassa, $4\frac{1}{4}$ parts; alder or willow charcoal, $5\frac{3}{4}$; sulphur, $22\frac{1}{2}$; nitrate of strontia, $67\frac{1}{2}$. For pots.

Green Fire.—1. Charcoal and sulphuret of arsenic, of each, $1\frac{3}{4}$ part; sulphur, $10\frac{1}{2}$; chlorate of potassa, $23\frac{1}{4}$; nitrate of baryta, $62\frac{1}{2}$. 2. Nitrate of baryta, 77 parts; chlorate of potassa, 8; fine charcoal, 3; sulphur, 13. 3. Metallic arsenic, 2 parts; charcoal, 3; chlorate of potassa, 5; sulphur, 13; nitrate of baryta, 77.

Lilac Fire.—Black oxide of copper, 6 parts; dry chalk, 20; sulphur, 25; chlorate of potassa, 49.

Purple Fire.—1. Sulphuret of antimony, $2\frac{3}{4}$ parts; black oxide of copper, 10; sulphur and nitrate of potassa, of each, $22\frac{3}{4}$; chlorate of potassa, 42. 2.

Sulphur, 12 parts; black oxide of copper, 12; chlorate of potassa, 30.

Red Fire.—1. Sulphur, sulphuret of antimony, and nitre, of each, 1 part; dried nitrate of strontia, 5. 2. Chlorate of potassa, 20 parts; sulphur, 24; nitrate of strontia, 56. 3. Coal-dust, 2 parts; gunpowder, 6; sulphur, 20; dried nitrate of strontia, 72. 4. Nitrate of strontia, $37\frac{1}{2}$ parts; flowers of sulphur, 10; charcoal, $1\frac{1}{4}$; powdered chlorate of potash, 5; black sulphur of antimony, $3\frac{1}{8}$.

Violet Fire.—Charcoal, 8 parts; sulphur, 10; metallic copper, 15; chlorate of potassa, 30.

White Fire.—1. Nitre, 60 parts; sulphur, 20; black antimony, 10; meal-powder, 6; powdered camphor, 4. 2. Gunpowder, $12\frac{1}{2}$ parts; zinc filings, 18; sulphur, 23; nitre, $46\frac{1}{2}$. 3. Charcoal, 1 part; sulphur, 24; nitre, 75.

Yellow Fire.—1. Sulphur, 16 parts; dried carbonate of soda, 23; chlorate of potassa, 61. 2. Charcoal, 6 parts; sulphur, $19\frac{1}{2}$. For pans.

Pyrotechnic Mixtures:—

White Light.—Saltpetre, 8 parts; sulphur, 2; antimony, 2.

Red Light.—Nitrate of strontia, 20 parts; chlorate of potash, 5; sulphur, $6\frac{1}{2}$; charcoal, 1.

Blue Light. — Chloride of potash, 9 parts; sulphur, 3; carbonate of copper, 3.

Yellow Light. — Nitrate of soda, 24 parts; antimony, 8; sulphur, 6; charcoal, 1.

Green Light.—Nitrate of baryta, 20 parts; chlorate of potash, 18; sulphur, 10.

Violet Light.—Nitrate of strontia, 4 parts; chlorate of potash, 9; sulphur, 5; carbonate of copper, 1; calomel, 1.

Matches. — Ordinary matches are small slips of wood which have been dipped in sulphur, and afterwards tipped with a paste capable of ignition by friction. This paste contains—1. Common phosphorus, 4 parts; nitre, 16; red-lead, 3; strong lead, 6. 2. Ordinary phosphorus, 9 parts; nitre, 14; binoxide of manganese, 14; gum or glue, 16. Melt the glue at 212° F., gradually add the phosphorus, which must be well stirred into the liquid; then add the nitre and colouring matter. Keep the paste at a regular temperature of about 97° F. by means of hot water under the marble or cast-iron slab on which it is spread whilst the matches are being dipped. If gum is used, all the operations may be more easily performed, as the materials can be mixed cold; but the matches made with gum are easily spoilt by damp.

Matches without Sulphur.—Char the ends of the splints with red-hot iron, dip them into a thin layer of stearic acid, or wax, melted in a flat-bottomed tinned copper pan. The dipping paste for these matches is ordinary phosphorus, 3 parts; strong glue, 3·5; water, 3; fine sand, 2·0; colouring matter, ·1 to ·5; chlorate of potash, 3. These matches burn readily, with a bright flame, and have no unpleasant smell. Amorphous phosphorus not being poisonous, or liable to accidental ignition, is preferable to ordinary phosphorus. The paste used is amorphous phosphorus, 3 parts; chlorate of potash, 4; glue, 2·5; water, 5; pounded glass, 2.

Safety Matches.—Dip the splints in a paste composed of chlorate of potash, 6 parts; sulphide of antimony, 2 to 3; glue, weighed dry, 1. The paste for the rubbing surface is amorphous phosphorus, 10 parts; oxide of manganese, or sulphide of antimony, 8; glue, 3 to 6, weighed dry. The ingredients must be thoroughly mixed, and care must be taken not to mix the chlorate of potash in the dry state with the other materials; it should be mixed first with glue dissolved in warm water. The paste for the rubbing surface may be spread with a brush or spatula on the side of the box.

Matches without Phosphorus.—1. For the production of these lucifers a mixture of from 4 to 6 parts of chlorate of potash, and 2 parts each of bichromate of potash, and of oxide of iron or of lead, with 3 parts strong glue is used. For the igniting surface, a mixture of 29 parts sulphate of antimony, 2 to 4 parts bichromate of potash, 4 to 6 parts

oxide of either iron, lead, or manganese, 2 parts of glass powder, and from 2 to 3 parts strong glue or gum. These matches will ignite only on the friction surface thus prepared. 2. For the match-heads a mixture of chlorate of potash and a compound of hyposulphurous acid with soda, ammonia, and oxide and sub-oxide of copper. This compound is formed by dividing a solution of copper into two equal parts, supersaturating one of them with ammonia, and the other with hyposulphate of soda; then mixing the two solutions, and stirring the mixture well, a violet powder precipitates. One part of it is to be mixed with 2 parts of the chlorate of potash, and a small quantity of pounded glass. Lucifers made in this way are, however, objectionable, from the fact that they will ignite on any rough surface, even more easily than the common kind.

Gun-Cotton. — There are several varieties of gun-cotton — the explosive, soluble only in acetic ether; pyroxiline, soluble in sulphuric ether and alcohol; and xyloidine. All these are formed by the action of nitric acid on cotton or lignine in some form. The difference between them consists mainly in the strength and temperature of the acids employed in their preparation. The most explosive is prepared with the strong acids, sulphuric and nitric, mixed, the object of the sulphuric being to take water from the nitric, and so leave the latter in its full strength to combine with the lignine or cotton. The first thing to be done is to thoroughly cleanse the raw material. This is effected by boiling it in an alkaline solution, then drying it in a current of air, and then again boiling it in clean water. After the second boiling it must be very *thoroughly* dried at about 120° F. The cotton must be *very* thoroughly dried, as any moisture which might remain in it would, by combining with the acid, generate heat, and set up a destructive action. The cotton, in charges of 1 lb., is placed separately in a bath containing the mixed acids, the mixture in which the cotton is submerged consisting of 3 parts by weight of Nordhausen sulphuric acid, specific gravity 1·84, and 1 part of nitric acid, specific gravity 1·5; this mixture allowed to cool down—a process which occupies two or three days—before the cotton is placed in it. After immersion, the charges of cotton are strained until each contains only about 10 times its weight of acids, and each charge is then placed in an earthenware jar and covered down. In order to prevent any heating from taking place, the jars should be placed in a current of *cold* water. The cotton after being exposed to the acid for 48 hours, in order to ensure its thorough conversion, is removed from the jars and squeezed nearly dry. It is then to be *suddenly* plunged into a *strong* fall of cold water, and left for a short time. The object of placing the gun-cotton in the fall of water is to ensure the sudden and complete submersion of the material, and thus avoid the heating and decomposition of the cotton, which would take place at the surface of the water if the cotton were immersed gradually. On its removal from the fall of water, the gun-cotton is wrung dry, and placed in a stream of water for 48 hours. After being washed and partly dried several times more, the cotton should be thoroughly dried at the temperature of no more than 140° F. It is now so explosive that great care is required in its arrangement, being about three times as explosive as gunpowder. As thus prepared gun-cotton scarcely differs from unchanged cotton in appearance; it is white and fibrous, and rather harsh to the touch. If only a small quantity is required—1. Mix 4½ oz. of pure, dry, nitrate of potash with 30 fluid drachms of sulphuric acid, sp. gr. 1·845, and stir into this mixture carefully 120 grs. of best carded cotton. As soon as saturation is complete, in about one minute, if proper care has been used, throw the cotton into a large pan of clean rain water, and change the water repeatedly until litmus ceases to show the presence of acid, then squeeze it in a cloth, and, after being well pulled out, dry it at a temperature of about 180°. 2. Take

of cotton 1 oz., sulphuric acid, 5 fl. oz., nitric acid, 5 fl. oz.; mix the acids in a porcelain mortar, immerse the cotton in the mixture, and stir it for three minutes with a glass rod, decant the liquid, pour more water on the mass, and repeat the process until the washing ceases to give a precipitate with chloride of barium. Drain the product on filtering paper and dry in a water bath.

Nitro-Glycerine. — Nitro-glycerine is made in the following manner:— Fuming nitric acid (sp. gr. about 1·52) is mixed with twice its weight of the strongest sulphuric acid, in a vessel kept cool by being surrounded with cold water. When this acid mixture is properly cooled, there is slowly poured into it rather more than $\frac{1}{6}$ of its weight of syrupy glycerine; constant stirring is kept up during the addition of the glycerine, and the vessel containing the mixture is maintained at as low a temperature as possible by means of a surrounding of cold water, ice, or some freezing mixture. It is necessary to avoid any sensible heating of the mixture, otherwise the glycerine, which is the sweet principle of oil, would be, to a considerable extent, transformed into oxalic acid. When the action ceases, nitro-glycerine is produced. It forms on the surface as an oily-looking fluid, the undecomposed sulphuric acid forming the subjacent layer, owing to its greater specific gravity. The whole mixture is then poured, with constant stirring, into a large quantity of cold water, when the relative specific gravities become so altered that the nitro-glycerine subsides and the diluted acid rises to the surface. After the separation in this manner into two layers is effected, the upper layer may be removed by the process of decantation or by means of a siphon, and the remaining nitro-glycerine is washed and re-washed with fresh water till not a trace of acid reaction is indicated by blue litmus paper. The final purifying process is to crystallize the nitro-glycerine from its solution in wood naphtha. The final process is not necessary when the compound is to be used at once. As prepared in this manner, nitro-glycerine is an oily-looking liquid, of a faint yellow colour, perfectly inodorous, and possessed of a sweet, aromatic, and somewhat piquant taste. It is poisonous, small doses of it producing headache, which may also be produced if the substance is absorbed into the blood through the skin, and hence it is not desirable to allow it to remain long in contact with the skin, but rather to wash it off as soon as possible with soap and water. Glycerine has a specific gravity of 1·25–1·26, but the nitro-glycerine has a specific gravity of almost 1·6, so that it is a heavy liquid. It is practically insoluble in water, but it readily dissolves in ether, in ordinary vinic alcohol, and in methylic alcohol or wood spirit. If it is simply exposed to contact with fire it does not explode, although it is so powerful as an explosive. A burning match may be introduced into it without producing any explosion; the match may be made to ignite the liquid, but combustion will cease as soon as the match ceases to burn. Nitro-glycerine may even be burned by means of a cotton wick or a strip of bibulous paper, as oil from a lamp, and as harmlessly. It remains fixed and perfectly unchanged at 212° F.; if heated to about 360°, however, it explodes. It detonates when struck by the blow of a hammer, but only the part struck by the hammer explodes; the surrounding liquid remains unchanged. As the carriage of nitro-glycerine is dangerous, many trials have been made to render it inexplosive, and to restore its explosiveness with equal readiness. Nobel's method of making it inexplosive is at once simple and effective. It is to mix with it from 5 to 10 per cent. of wood spirit, when all attempts at exploding it are rendered utterly futile. Five per cent. of methyl-alcohol is said to be amply sufficient to transform the nitro-glycerine into the inexplosive or protected state, but 10 per cent. is generally added before sending any liquid into the market. The transformation of protected into ordinary nitro-glycerine is effected by thoroughly agitating it with water, and

allowing the mixture to settle for a short time. By this means the water dissolves out the methyl-alcohol, and the mixture of spirit and water readily rises to the surface, in virtue of its low specific gravity, and can be removed by means of a siphon, or by simply pouring it off. As a blasting liquid it is now ready for use. If protected blasting liquid be kept in a closed vessel, it will remain in that state for an indefinite period of time, and ready at any moment to be reduced or rendered fit for action; if, however, it be exposed in an open vessel, it will regain its explosiveness, in periods of time proportionate to the amount or degree of exposure. For blasting purposes, the chief advantage which nitro-glycerine possesses is that it requires a much smaller hole or chamber than gunpowder does, the strength of the latter being scarcely $\frac{1}{10}$ that of the former. A chamber, 34 millimètres in diameter, was made perpendicularly in a dolomitic rock, 60 ft. in length, and at a distance of 14 ft. from its extremity, which was nearly vertical. At a depth of 8 ft., a vault filled with clay was found, in consequence of which the bottom of the hole was tamped, leaving a depth of 7 ft. One litre and a half of nitro-glycerine was then poured in; it occupied 5 ft. A match and stopper were then applied as stated, and the mine sprung. The effect was so enormous as to produce a fissure 50 ft. in length, and another of 20 ft. Nitro-glycerine has, however, one disadvantage. It freezes at a temperature very probably above 92° F., and it is said that even at a temperature of 43° to 46° F. the oil solidifies to an icy mass, which mere friction will cause to explode. It is probable, however, that the freezing-point of the oil lies somewhat lower than is here stated, though as yet no exact determination of the freezing-point of the oil has been made. Great care must be exercised whilst it is in a frozen state, as otherwise it will cause most dreadful accidents.

Dynamite is made by mixing 75 per cent. of nitro-glycerine with 25 per cent. of powdered sand. Dynamite retains all the properties of nitro-glycerine for blasting, but is not so dangerous, as it may be handled freely. Explosion is produced by means of a percussion cap in the same manner as with nitro-glycerine.

Fulminates.—*Fulminate of Mercury.*—1. This highly-explosive compound consists of protoxide of mercury united with an acid; fulminic acid, formed of cyanogen and oxygen. Fulminate of mercury is prepared by causing alcohol to react on the acid protonitrate. A quantity of mercury is dissolved in 12 parts of nitric acid of 35° or 40° of Baumé, and 11 parts of alcohol at ·86 are gradually added to the solution; while the temperature is slowly elevated, a lively reaction, accompanied by a copious evolution of reddish vapours, soon ensues, when the liquid, on cooling, deposits small crystals of a yellowish white colour. Fulminate of mercury is one of the most explosive compounds known, and should be handled with great care, especially when it is dry, and it detonates when rubbed against a hard body. It dissolves readily in boiling water, but the greater portion is again deposited in crystals during cooling. The fulminating material of percussion caps is made of fulminate of mercury prepared as just stated, after having been washed in cold water. The substance is allowed to drain until it contains only about 20 per cent. of water, and is then mixed with $\frac{3}{5}$ of its weight of nitre, which mixture is ground on a marble table with a muller of guiacum-wood. A small quantity of the paste is then placed in each copper cap and allowed to dry, the fulminating powder in the cap being often covered with a thin coat of varnish to preserve it from moisture. 2. Weigh out 25 grains of mercury in a watch-glass, transfer it to a half-pint pipkin, add a measured $\frac{1}{2}$ oz. of ordinary concentrated nitric acid, sp. gr. 1·42, and apply a gentle heat. As soon as the mercury is completely dissolved, place the pipkin upon the table away from any flame, and pour quickly into it, at arm's length, 5 measured drachms of

alcohol, sp. gr. 0·87. A brisk action will ensue, and heavy white clouds will arise. When this action has subsided, fill the pipkin with water, allow the fulminate to settle, and then pour off the liquid acid. Collect the fulminate on a filter, and wash with water as long as the washing tastes acid, then dry by exposure to the air. This explodes at a temperature of 360° F., or by being touched by a glass rod which has been dipped in concentrated nitric or sulphuric acid. An electric spark also explodes it.

Fulminate of Silver. — Dissolve 10 grains of pure silver, at a gentle heat, in 70 minims of ordinary concentrated nitric acid, sp. gr. 1·42, and 50 minims of water. As soon as the silver is dissolved the heat is removed, and 200 minims of alcohol, sp. gr. 0·87, are added. If the nitric acid and alcohol are not of the exact strength here given it may be difficult to start the action, in which case add two or three drops of red nitric acid, which contains nitrous acid. Standard silver, containing copper, may be used for the preparation of the fulminate. If the action does not commence after a short time, a very gentle heat may be applied until effervescence begins, when the fulminate of silver will be deposited in minute needles, and may be further treated as in the case of fulminate of mercury. As the fulminate of silver is exploded much more readily than the fulminate of mercury, it must be handled with the greatest caution when dry. It should be separated into small quantities, each portion wrapped in paper, and kept in a cardboard box, nothing harder than this should be brought in contact with it. This mixture is of no use for percussion caps, being too violent in its action.

Throw-down Detonating Cracker. — Screw up a particle of fulminate of silver in a piece of thin paper, with some fragments of a crushed quartz pebble.

Double Fulminate of Silver and Ammonia.—Dissolve fulminate of silver in warm ammonia: the solution, on cooling, will deposit crystals of the double fulminate. This is very violent in its explosion, and is dangerous whilst still moist.

Fulminating Platinum.—Dissolve binoxide of platinum in diluted sulphuric acid, mix the solution with excess of ammonia, a black precipitate is obtained, which detonates violently at about 400° F.

Fulminating Gold.—Add ammonia to a solution of terchloride of gold; the buff precipitate which it deposits is violently explosive at a gentle heat.

Terchloride of Gold.—Dissolve gold in hydrochloric acid, with one-fourth of its volume of nitric acid. Evaporate on a water bath to a small bulk; when cool, yellow prismatic crystals of a compound of the terchloride, with hydrochloric acid are deposited, from which the hydrochloric acid may be expelled by a gentle heat, not exceeding 250° F. The terchloride forms a red brown deliquescent mass, which dissolves very readily in water.

Gunpowder. — The component parts of gunpower are saltpetre, sulphur, and charcoal, used in the following proportions:—1. English war powder.—Saltpetre, 75 parts; sulphur, 10; charcoal, 15. 2. French war powder.—Saltpetre, 75 parts; sulphur, 12·5; charcoal, 12·5. 3. French sporting powder.—Saltpetre, 76·9 parts; sulphur, 9·6; charcoal, 13·5. 4. French blasting powder.—Saltpetre, 62 parts; sulphur, 20; charcoal, 18. There are a number of variations of the above receipts; but the difference, which is purely a matter of opinion, consists principally in varying the quantity of sulphur or charcoal employed.

Saltpetre.—Crude saltpetre cannot be used for making gunpowder. The crystalline flour, quite free from chloride, is the best for the purpose. The washing process is carried so far that nitrate of silver produces no precipitate in the purified saltpetre. The general rule is to use the saltpetre whilst slightly damp, allowing for the proportion of moisture when mixing with the other ingredients. This saves the processes of drying and grinding the saltpetre before mixing with the sulphur and charcoal.

SULPHUR.—Refined sulphur in rolls is used. This must be reduced to an impalpable powder, which is usually effected by placing the sulphur in hollow wooden drums, having projections, or brackets inside. A number of small brass balls are put into the drum with the sulphur, and the drum is made to revolve for six hours, when the action of the balls and projections reduces the sulphur to very fine powder, which is then extracted through wire gauze. Any small particles of sand, or unequally pulverized sulphur, are then separated by a bolting machine.

CHARCOAL.—The quality of the charcoal depends greatly upon the material from which it is obtained, and the manner in which it is prepared. The soft, woody parts of plants, which yield a friable, porous charcoal, leaving very little ash, are preferred. Black alder, and spindle tree, poplar, chestnut, vine-stalks and willow, are most esteemed. Hemp-stalks, fibres of flax, and old linen also yield a very good charcoal. Remove the bark, leaves, and smaller branches, selecting branches from 1 to 2 inches in thickness. These are to be cut into lengths of 5 or 6 feet, and tied in bundles, weighing about 30 lbs. The wood will not be injured by exposure to the rain, as that tends to remove extractive matter. The carbonization is effected either in pits, or in cast-iron cylinders. The yield of charcoal is 18 to 20 per cent., when prepared in pits; and from 35 to 40 per cent. when prepared in the cast-iron cylinders. The process of manufacture is similar to that adopted for ordinary charcoal, the pits or cylinders, however, replacing the ordinary kiln. If the charcoal is intended for sporting powder, it may be withdrawn whilst of a brown colour, when it is called *red charcoal*. This would make a powder too explosive for war purposes; this must be prepared from the *black* or *distilled charcoal*, which is more completely calcined, and is used by all English makers. The best quality has a bluish black colour, is light, firm, and slightly flexible, and should be used immediately it is made, as it rapidly deteriorates by keeping. Charcoal that has been too highly burned for war powder is used in the manufacture of blasting powder, as that need not be so inflammable.

Pulverizing.—The required quantities of sulphur and charcoal are thoroughly pulverized, and intimately mixed, by being rolled for about four hours in a cast-iron drum, with numerous small brass balls, at a speed of about 28 revolutions a minute. When the mixture is complete, the powdered sulphur and charcoal is removed from the drum, and a proportionate quantity of saltpetre is added. Great care must be used in weighing out the various ingredients, according to the quality of the powder required, as upon that, and the complete mixing of the materials, the success of the manufacture depends.

Mixing.—The powder is put in a mixing machine, which is a leather drum, in which are placed numerous small bronze balls. The machine revolves at from 25 to 30 revolutions a minute, and in about 4 hours' time the mixing is complete.

Granulating.—The powder having been damped and pressed into cakes, must then be crushed to the required size of grain. It is first roughly broken into lumps by small mallets; it is then fed into the granulating machine, which is caused to revolve for 35 or 40 minutes, at about 10 revolutions a minute. A small stream of water enters the granulator; the movement of the machine rolling the damp grains constantly among the dry meal powder, causes the latter to adhere to their surface, and each grain is thus increased by concentric layers. When the small meal powder is all absorbed by the action of the granulator, the material is placed in a barrel ready for *equalization*.

Equalizing.—The grains as they come from the granulator are of various sizes, they are therefore sifted over two leather or parchment sieves, one of which is pierced to separate the grains which are too large, whilst the other allows all the dust to pass through, retaining only the grains which are of the desired size.

The small refuse powder which has passed through the sieve, is again placed in the granulator, and acted upon as before described.

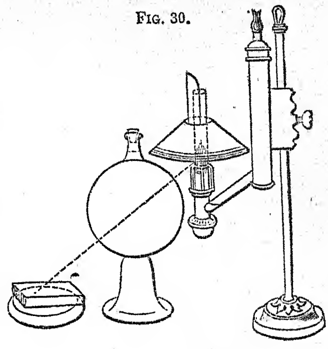
Glazing.—The powder is placed in a cask, or barrel, which revolves on its axis at about 40 revolutions a minute; by the friction of the grains against each other they become round, smooth, and polished, in which state the powder will bear the shaking and friction of carriage without injury, and is less likely to absorb moisture than when in rough and angular grains.

Drying.—The powder must not be too rapidly dried, a temperature commencing at about 66° F., and gradually increased to 130° or 140° F., is a safe one; the operation requires from 3 to 4 hours, and is best performed in a room warmed by steam pipes or hot-air flues. The powder is then fit for use, and may be packed in sacks, to be afterwards placed in casks, or in double casks; sporting powder is usually packed in tin canisters.

Pharaoh's Serpents.—Fuse in a crucible equal parts by weight of yellow prussiate of potash and flower of sulphur, frequently it is advisable, if the heat cannot be well regulated, to include a little carbonate of potash; lixiviate the mass with water and filter; the filtrate will be sulphocyanide of potassium, which, upon being added to a solution of mercury dissolved in nitric acid, gives a copious precipitate of sulphocyanide of mercury; collect this; wash well with water, and dry; roll into a small pyramid, cover with tin-foil, and when dry it is ready to be lit.

Engraving on Wood. — *Engraver's Lamp.* — A clear and steady light, directed immediately upon the block to be cut, is a most important point, and in working by lamplight it is necessary to protect the eyes from its heat and glare. The lamp shown in Fig. 30 can be raised or lowered at pleasure by sliding the bracket up or down the standard, it being fixed in the desired position by means of the small set screw. A large globe of transparent glass, filled with clean water, placed between the lamp and the block, causes the light to fall directly upon the block.

FIG. 30.

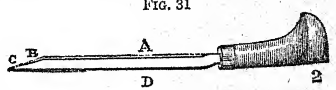


The dotted line shows the direction of the light; by lowering the lamp this light would take a more horizontal direction, thus enabling the engraver to work farther from the lamp. A shade over the eyes is occasionally used as a protection from the light of the lamp.

TOOLS.—These consist of gravers, tint-tools, gouges or scoopers, flat tools or chisels, and a sharp-edged scraper, something like a copper-plate engraver's burnisher, which is used for lowering the block. Of each of these tools several sizes are required.

Gravers.—The outline tool, Fig. 31, is chiefly used for separating one figure

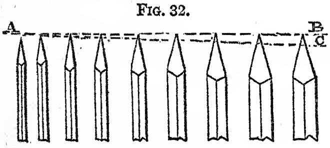
FIG. 31



from another, and for outlines. A is the back of the tool; B, the face; C, the point; D is technically termed the belly. The horizontal line, 2, shows the surface of the block. All the handles when received from the turner's are circular, but as soon as the tool has been inserted a segment is cut away from the lower part, so that the tool may clear the block. The blade should be very fine at the point, so that the line it cuts may not be visible when the block is printed, its

chief duty being to form a termination to a number of lines running in another direction. Although the point should be fine, the blade must not be too thin, for it would then only make a small opening, which would probably close up when the block was put in the press. When the tool becomes too thin at the point, the lower part must be rubbed on a hone to enable it to cut out the wood instead of sinking into it. Nine gravers of different sizes, starting from the outline tool, are sufficient for ordinary work. The blades as made are very similar to those used in copperplate engraving; the necessary shape for wood engraving is obtained by rubbing the points on a Turkey stone. The faces, and part of the backs, of nine gravers of different sizes, are shown on Fig. 32;

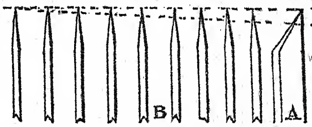
FIG. 32.



the dotted line, A C, shows the extent to which the tool is sometimes ground down to broaden the point. This grinding rounds the point of the tool, instead of leaving it straight, as shown at A B. Except for the parallel lines, called *tints*, these gravers are used for nearly all kinds of work. The width of the line cut out is regulated by the thickness of the graver near the point, and the pressure of the engraver's hand.

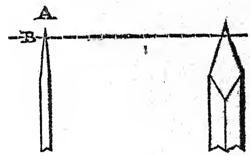
Tint-tools.—The parallel lines forming an even and uniform tint, as in the representation of a clear sky, are obtained by what is called the tint-tool, which is thinner at the back, but deeper at the side, than the graver, and the angle of the face at the point is much more acute, as shown on Fig. 33: A is a side view of the blade; B shows the faces of nine tint-tools of varying fineness. The handle is of the same form as that used for the graver. The graver should not be used in place of the tint-tool, as from the greater width of its point a very slight inclination of the hand will cause a perceptible irregu-

FIG. 33.



larity in the distance of the lines, besides tending to undercut the line left, which must be carefully avoided. Fig. 34 shows the points and faces of the

FIG. 34.



two tools, from a comparison of which this statement will be readily understood. As the width of the tint-tool at B is little more than at A, it causes only a very slight difference in the distance of the lines cut, if inclined to the right or the left, as compared with the use of the graver. Tint-tools that are strong in the back are to be preferred as less likely to bend, and giving greater freedom of execution than weak ones. A tint-tool that is thicker at the back than at the lower part, leaves the black raised lines solid at their base, as in Fig. 35,

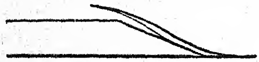
FIG. 35.

FIG. 36.

the block being less liable to damage than in the case of Fig. 36, in which the lines are no thicker at their base than at the surface. The face of both gravers and tint-tools should be kept rather long than short; though if the point be ground too fine it will be very liable to break. When, as in Fig. 37, the face is long,—or, strictly speaking, when the angle formed by the plane of the face

and the lower line of the blade is comparatively acute,—a line is cut with

FIG. 37.

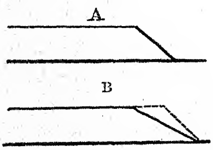


much greater clearness than when the face is comparatively obtuse, and the small shaving cut out turns gently over towards the hand. When, however, the face of the tool approaches to the shape seen in Fig. 38, the reverse happens; the

FIG. 38.

small shaving is rather ploughed out than cleanly cut out; and the force necessary to push the tool forward frequently causes small pieces to fly out at each side of the hollowed line, more especially if the wood is dry. The shaving, also, instead of turning aside over the face of the tool, turns over before the point, as in Fig. 38, and hinders the engraver from seeing that part of the pencilled line which is directly under it. A short-faced tool of itself prevents the engraver from distinctly seeing the point. When the face of a tool has become obtuse it ought to be ground to a proper form; for instance, from the shape of the figure A to that of B, Fig. 39.

FIG. 39.



Preparing Gravers and Tint-tools.—Gravers and tint-tools, when first received from the makers, are generally too hard—a defect that is soon discovered by the point breaking off short as soon as it enters the wood. To remedy this, the blade of the tool must be tempered to a straw colour, and either dipped in sweet oil, or allowed to cool gradually. If removed from the iron while it is still of a straw colour, it will have been softened no more than sufficient; but should it have acquired a purple tinge, it will have been softened too much, and instead of breaking at the point, as before, it will bend. A small grindstone is of great service in grinding down the faces of tools that have become obtuse. A Turkey stone is a very good substitute, as, besides reducing the face, the tool receives a point at the same time; but this requires more time. Some engravers use only a Turkey stone for sharpening their tools; a hone in addition is of great service. A graver that has received a final polish on a hone cuts a clearer line than one which has only been sharpened on a Turkey stone; it also cuts more pleasantly, gliding smoothly through the wood, if it be of good quality, without stirring a particle on either side of the line. The gravers and tint-tools used for engraving on a plane surface are straight at the point, as are here represented, Figs. 40 and 41; but for engrav-

FIG. 40.

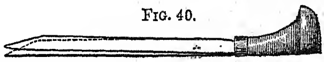
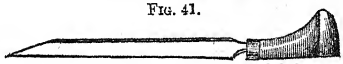


FIG. 41.

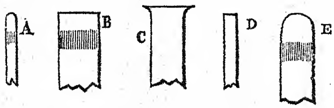


ing on a block rendered concave in certain parts by lowering, it is necessary that the point should incline slightly upwards, as in Fig. 40. The dotted line shows the direction of the point used for plane surface engraving. There is no difficulty in getting a tool to descend on one side of a part hollowed out or lowered; but unless the point is slightly inclined upwards, as is here shown, it is extremely difficult to make it ascend on the side opposite without getting too much hold, and thus producing a wider white line than intended.

Gouges and Chisels, A to E, Fig. 42.—Gouges of different sizes are used for scooping out the wood towards the centre of the block; whilst flat tools, or chisels, are chiefly employed in cutting away the

wood towards the edges, about one-eighth of an inch below the subject. The gouge

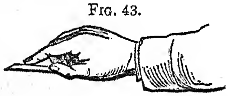
Fig. 42.



is similar to an ordinary carpenter's gouge, except that it is solid, being a round bar, with the end ground off at an angle. The other articles required are, a sand-bag, on which to rest the block whilst engraving it; an agate burnisher, and a dabber, which are used for taking proof-impressions of the wood-cut; an oil stone, and eye-glass with shade.

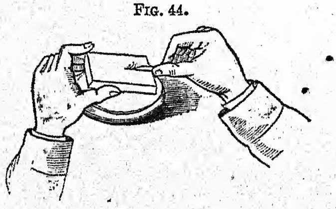
Holding the Graver.—Engravers on copper and steel, who have much harder substances than wood to cut, hold the graver with the forefinger extended on the blade beyond the thumb, Fig. 43, so

Fig. 43.



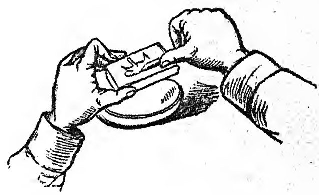
that by its pressure the point may be pressed into the plate. As boxwood, however, is much softer than these metals, and as it is seldom of perfectly equal hardness throughout, it is necessary to hold the graver in a different manner, and employ the thumb at once as a stay or rest for the blade, and as a check upon the force exerted by the palm of the hand, the motion being chiefly

Fig. 44.



guided by the forefinger, as is shown in Fig. 44. The thumb, with the end resting against the side of the block, in the manner just represented, allows the blade to move backwards and forwards with a slight degree of pressure against it, and in case of a slip, it is ever ready to check the graver's progress. This mode of resting the thumb against the edge of the block is, however, only applicable when the cuts are so small as to allow the graver, when thus guided and controlled, to reach every part of the subject. When the cut is too large to admit of this, the thumb then rests upon the surface of the block, as in Fig. 45,

Fig. 45.



still forming a stay to the blade of the graver, and checking at once any accidental slip.

Wood.—For large coarse cuts, such as are often used for trade purposes, sycamore and pear tree may be employed, but are too soft and irregular in the grain to bear fine work. Boxwood, either English, American, or from the Levant, is the favourite material; it should be of a light straw yellow colour, free from black or white spots or red streaks, as these indicate a soft wood, which crumbles away under the graver. The small wood is generally tolerably free from blemishes. When a large cut is wanted, if a block of the required size is not at hand, several smaller blocks are sometimes bolted together. The blocks are cut a trifle thicker than the height of type, about an inch; they are then planed, brought to a very smooth surface, and gauged to the exact height of type. These blocks should be kept for some months until they are properly seasoned.

Drawing on the Block.—The polished boxwood will not take the pencil with-

out a slight wash is first laid on it. A thin wash of Chinese white mixed with water, some very fine Bath brick dust, or the white scrapings of glazed cardboard, mixed with water, and gently rubbed off when dry with the palm of the hand, gives a capital surface for the black-lead pencil. Make a tracing of the outline of the subject, place a sheet of transfer paper on the block, lay the tracing over it, and go carefully over every line with a sharp point. It must be remembered that the woodcut will be reversed when printed. The outlines must be corrected, and completed, by a hard sharp-pointed H H H H pencil; the tints may afterwards be filled in by a softer pencil, or thin washes of Indian ink, to show the effect of light and shade. Caution must be taken to use these washes sparingly, so as not to affect the wood. All parts of the block, not being cut, must be kept covered up, so as to preserve the drawing from injury, and the fine lines of the cut from being blunted or broken. Smooth blue glazed paper is very good for this purpose, as it reduces the glare from the lamp.

Proofs.—When the engraving is finished, a proof may be taken in the following manner before blocking out the cut, that is, before the superfluous wood is cleared away;—rub down a little printer's ink on a slab till it is fine and smooth; take a little of this on a silk dabber, and carefully dab the block until sufficient ink is left upon the surface, without allowing any to sink below it. Lay a piece of India paper on the block with about two inches margin all round; on this place a thin smooth card; rub this over with the burnisher, taking care not to shift the card or paper.

Plugging.—If a slip, or mistake, occurs in a woodcut, it may be remedied by the insertion of a plug. A hole must be drilled in the block; if the error is a small one the hole need not be deep, but if a large piece has to be inserted it must be deeper in proportion. A plug is cut, of a round, taper shape; the small end is inserted in the hole, and the plug is driven down, without, however, using too much force. The top of the plug must then be cut off, and carefully brought to a smooth surface, level with the rest of the block; if this is not done the plug will be visible on the print. If the error to be remedied happens to be in a long line, a hole must be drilled at each end, and the wood between the two holes removed by small chisels, the hollow space being filled up in a similar way to that already described.

Lithography.—The following are the principles on which the art of lithography depends;—the facility with which calcareous stones imbibe water; the great disposition they have to adhere to resinous and oily substances; and the affinity between each other of oily and resinous substances, and the power they possess of repelling water, or a body moistened with water. Hence, when drawings are made on a polished surface of calcareous stone, with a resinous or oily medium, they are so adhesive that nothing short of mechanical means can effect their separation from it; and whilst the other parts of the stone take up the water poured upon them, the resinous, or oily parts, repel it. When, therefore, over a stone prepared in this manner, a coloured oily or resinous substance is passed, it will adhere to the drawings made as above, and not to those parts of the stone which have been watered. The ink and chalk used in lithography are of a saponaceous quality; the former is prepared in Germany from a compound of curd or common soap, pure white wax, a small quantity of tallow and shellac, and a portion of lampblack, all boiled together, and, when cool, dissolved in distilled water. The chalk for the crayons used in drawing on the stone is a composition consisting of the ingredients above mentioned. After the drawing on the stone has been executed, and is perfectly dry, a very weak solution of nitric acid is poured upon the stone, which not only takes up the alkali from the chalk or ink, as the case may be, leaving an insoluble substance behind it, but lowers, to a small extent, that part of the surface of the stone not drawn upon, thus preparing it to absorb water with greater freedom. Weak gum water is then applied to the

stone, to close its pores and keep it moist. The stone is now washed with water, and the printing ink applied with rollers, as in letterpress printing; after which it is passed, in the usual way, through the press, the processes of watering and inking being repeated for every impression. If the work is inclined to get smutty a little vinegar or stale beer should be put into the water that is used to damp the stone.

There is a mode of transferring drawings made with the chemical ink on paper prepared with a composition of paste, isinglass, and gamboge, which, being damped, laid on the stone and passed through the press, leaves the drawing on the stone, and the process above described for preparing the stone and taking the impressions is carried into effect.

Lithographic Stones, to Prepare.—Stones are prepared for chalk drawings by rubbing two together, with a little silver sand and water between them, taking care to sift the sand to prevent any large grains from getting in, by which the surface would be scratched. The upper stone is moved in small circles over the under one till the surface of each is sufficiently even, when they are washed, and common yellow sand substituted for the silver sand, by which means is procured a finer grain. They are then again washed clean, and wiped dry. It will be found that the upper stone is always of a finer grain than the under one. To prepare stones for writing or ink drawings, they are rubbed with brown sand, washed, and powdered pumice-stone used instead; the stones are again washed, and each polished separately with a fine piece of pumice-stone, or water Ayr-stone. Chalk can never be used on the stones prepared in this manner. The same process is followed in order to clean a stone that has already been used.

Lithographic Ink.—Tallow, 2 oz.; virgin wax, 2 oz.; shellac, 2 oz.; common soap, 2 oz.; lampblack, ½ oz. The wax and tallow are first put in an iron saucepan with a cover, and heated till they ignite; whilst they are burning the soap must be thrown in in small pieces, one at a time, taking care that the first is melted before a second is put in. When all the soap is melted the ingredients are allowed to continue burning till they are reduced one-third in volume. The shellac is now added, and as soon as it is melted the flame must be extinguished. It is often necessary in the course of the operation to extinguish the flame and take the saucepan from the fire, to prevent the contents from boiling over; but if any parts are not completely melted, they must be dissolved over the fire without being again ignited. The black is now to be added. When it is completely mixed the whole mass should be poured out on a marble slab, and a heavy weight laid upon it to render its texture fine. The utmost care and experience are required in the making both the ink and chalk, and even those who have had the greatest practice often fail. Sometimes it is not sufficiently burned, and when mixed with water appears slimy: it must then be remelted and burned a little more. Sometimes it is too much burned, by which the greasy particles are more or less destroyed; in this case it must be remelted, and a little more soap and wax added. This ink is for writing or pen-drawing on the stone. The ink for transfers should have a little more wax in it.

Lithographic Chalk.—Common soap, 1½ oz.; tallow, 2 oz.; virgin wax, 2½ oz.; shellac, 1 oz.; lampblack, ½ oz. Mix as for *lithographic ink.*

Lithographic Transfer Paper.—Dissolve in water ½ oz. gum tragacanth. Strain and add 1 oz. of glue and ½ oz. of gamboge. Then take 4 oz. French chalk, ½ oz. old plaster of Paris, 1 oz. starch; powder, and sift through a fine sieve; grind up, with the gum, glue, and gamboge; then add sufficient water to give it the consistence of oil, and apply with a brush to thin sized paper.

Transferring.—The drawing or writing made on the prepared side of the transfer paper is wetted on the back, and placed, face downwards, on the stone, which must previously be very slightly warmed, say to about 125° F. Pass the stone through the press four or five times, then damp the paper, and carefully remove it.

Drawing on Stone.—The subject should first be traced on the stone in red, great care being taken not to touch the stone with the fingers. Or the drawing may be done by means of a black-lead pencil; but this is objectionable, as it is difficult to distinguish the line from that made by the chalk or ink. Then, having a rest to steady the hand, go over the drawing with the chalk, pressing it with sufficient firmness to make it adhere to the stone. For flat tints, considerable practice is necessary to secure an even appearance, which is only to be obtained by making a great many faint strokes over the required ground. Lights may either be left, or, if very fine, can be scraped through the chalk with a scraper. If any part is made too dark, the chalk must be picked off with a needle down to the required strength.

Etching-in, for Printing on Stone.—Dilute one part of aquafortis with one hundred parts of water. Place the stone in a sloping position, then pour the solution over it, letting it run to and fro until it produces a slight effervescence. Then wash the stone with water, and afterwards pour weak gum water over it. The acid, by destroying the alkali on the lithographic chalk, causes the stone to refuse the printing ink except where touched by the chalk; the gum water fills up the pores of the stone, and thus prevents the lines of the drawing from spreading. When the stone is drawn on with ink, there must be a little more acid used with the water than when the drawing is made with chalk. The roller charged with printing ink is then passed over the stone, which must not be too wet, and the impression is taken as before described.

Engraving on Stone.—The stone must be highly polished; pour the solution of aquafortis and water over it, washing it off at once. When dry, cover with gum water and lampblack; let this dry, then etch with a needle, as on copper. It is necessary to cut the surface of the stone through the gum, the distinction of light and dark lines being obtained by the use of fine or broad-pointed needles. Rub all over with linseed oil, and wash the gum off with water. The lines on the stone will appear thicker than they will print.

To Imitate Woodcuts on Stone.—Cover with ink those parts meant to be black; scratch out the lights with an etching needle; the lines which come against a white background are best laid on with a very fine brush and lithographic ink.

Inking Roller.—Fasten a smooth piece of leather round a wooden roller of the required length.

Removing the Transfer.—The existing transfer is ground away by rubbing it with another piece of stone, putting sand between, like grinding flour between the millstones, using finer sand as it gradually wears away; then it is ground with rotten-stone till of the requisite fineness for the next transfer.

Transferring from Copper to Stone.—In transferring from copper to stone use prepared paper, that is, ordinary unsized paper, coated with a paste of starch, gum-arabic, and alum. Take about 60 parts of starch, and mix with water to a thinnish consistency over a fire; have twenty parts of gum ready dissolved, and also ten parts of alum dissolved; when the starch is well mixed, put in the gum and alum. While still hot, coat the paper with it in very even layers, dry, and smooth out. Take an impression from the copper with the transfer ink; lay the paper on the stone, damp the back thoroughly with a sponge and water, and pass through the litho-press. If all is right, the impression will be found transferred to the stone, but it will of course require preparing in the usual manner. The great advantage gained is, that very many more impressions may be printed from stone than from a copper plate, and very much quicker.

Engraving on Steel is the same as copper-plate engraving, except in certain modifications in the use of the acids; therefore, so far as the process is concerned, no particular description is necessary; but the means employed for decarbonizing and recarbonizing first the steel plate, so as to reduce it to a proper state for being acted upon by the graving

tool, must be explained. In order to decarbonate the surfaces of cast-steel plates, by which they are rendered much softer and fitter for receiving either transferred or engraved designs, pure iron filings, divested of all foreign matters, are used. The stratum of decarbonated steel should not be too thick for transferring fine and delicate engravings; for instance, not more than three times the depth of the engraving; but for other purposes the surface of the steel may be decarbonated to any required thickness. To decarbonate it to a proper thickness for a fine engraving, it is to be exposed for four hours in a white heat, enclosed in a cast-iron box with a well-closed lid. The sides of the box must be at least three-quarters of an inch in thickness, and at least a thickness of half an inch of pure iron filings should cover or surround the cast-steel surface to be decarbonated. The box is allowed to cool very slowly, by shutting off all access of air to the furnace, and covering it with a layer of six or seven inches of fine cinders. Each side of the steel plate must be equally decarbonated, to prevent it from springing or warping in hardening. The safest way to heat the plates is to place them in a vertical position. The best steel is preferred to any other sort of steel for the purpose of making plates, and more especially when such plates are intended to be decarbonated. The steel is decarbonated to render it sufficiently soft for receiving any impression intended to be made thereon; it is, therefore, necessary that, after any piece of steel has been so decarbonated, it should, previously to being printed from, be again carbonated, or reconverted into steel capable of being hardened. In order to effect this recarbonization or reconversion into steel, the following process is employed; a suitable quantity of leather is to be converted into charcoal, by exposing it to a red heat in an iron retort until most of the evaporable matter is off the leather. The charcoal is reduced to a very fine powder; then take a box made of cast iron of sufficient dimension to receive the plate which is to be reconverted into steel, so as that the intermediate space between the sides of the box and the plate may be about an inch. Fill the box with the powdered charcoal, and, having covered it with a well-fitted lid, let it be placed in a furnace similar to those used for melting brass, when the heat must be gradually increased until the box is somewhat above a red heat; it must be allowed to remain in that state till all the evaporable matter is driven off from the charcoal; remove the lid from the box, and immerse the plate in the powdered charcoal, taking care to place it so that it may be surrounded on all sides by a stratum of the powder of nearly a uniform thickness. The lid being replaced, the box, with the plate, must remain in the degree of heat before described for from 3 to 4 hours, according to the thickness of the plate so exposed; 3 hours are sufficient for a plate of ½ an inch in thickness, and 5 hours when the steel is 1½ inch in thickness. After the plate has been exposed to the fire for a sufficient length of time, take it from the box and immediately plunge it into cold water. Here it is found by experience that the plates, when plunged into cold water, are least liable to be warped or bent when they are held in a vertical position, and made to enter the water in the direction of their length. If a piece of steel, heated to a proper degree for hardening, be plunged into water, and suffered to remain there until it becomes cold, it is found by experience to be very liable to crack or break, and in many cases it would be found too hard for the operations it was intended to perform. If the steel cracks it is spoiled. Therefore, to fit it for use, should it not be broken in hardening, it is the common practice to heat the steel again, in order to reduce or lower its temper. The degree of heat to which it is now exposed determines the future degree of hardness, or temper, and this is indicated by a change of colour upon the surface of the steel. During this heating a succession of shades is produced, from a very pale straw colour to a very deep blue. It is found that, on plunging the steel into cold water, and allowing it to remain there no longer

than is sufficient to lower the temperature of the steel to the same degree as that to which a hard piece of steel must be raised to temper it in the common way, it not only produces the same degree of hardness in the steel, but, what is of much more importance, almost entirely does away with the risk of its cracking. The proper degree of temperature arrived at, after being plunged into cold water, can only be learned by actual observation, as the workman must be guided entirely by the kind of hissing noise which the heated steel produces in the water while cooling. From the moment of its first being plunged into the water the varying sound will be observed; and it is at a certain tone, before the noise ceases, that the effect to be produced is known. As a guide, take a piece of steel which has already been hardened by remaining in the water till cold, and by the common method of again heating it, let it be brought to the pale yellow or straw colour, which indicates the desired temper of the steel plate to be hardened. By the above process, as soon as the workman discovers this colour to be produced, to dip the steel into water and attend carefully to the hissing which it occasions, he will then be able, with fewer experiments, to judge of the precise time at which the steel should be taken out. Immediately on withdrawing it from the water, the steel plate must be laid upon or held over a fire, and heated uniformly until its temperature is raised to that degree at which a smoke is perceived to arise from the surface of the steel plate after having been rubbed with tallow; the steel plate must then be again plunged into water, and kept there until the sound becomes somewhat weaker than before. It is to be taken out, and heated a second time to the same degree as before, and the third time plunged into water till the sound becomes again weaker than the last; exposed the third time to the fire as before; and for the last time returned into the water and cooled. After it is cooled clean the surface of the steel plate by heating it over the fire. The temper must be finally reduced by bringing on a brown or such colour as may suit the purpose required. The above is an old process and not generally used. Engraving on steel is effected nowadays by graving and etching like copper; using for biting-in a mixture of 1 part pyroligneous acid, 1 nitric acid, 3 water; run off from the plate in less than a minute, rinse in running water, and dry quickly. Use stronger acid when a deeper tint is required.

Engraving Steel Cylinders.—A cylinder of very soft or decarbonized steel is made to roll, under a great pressure, backward and forward on the hardened engraved plate till the entire impression from the engraving is seen on the cylinder in alto-relievo. The cylinder is then hardened and made to roll again backward and forward on a copper or soft steel plate, whereby a perfect facsimile of the original is produced of equal sharpness.

Etching.—The apparatus consists of copper plates, etching needles, hand-rest, etching-ground dabber, oil-rubber, rotten-stone, smoking taper, engraver's shade, bordering wax, stopping-out varnish, tracing paper, and aquafortis.

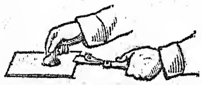
Ground.—The ground is composed of equal parts of asphaltum, Burgundy-pitch, and beeswax; place them in an earthen pipkin in an oven, and melt. The mass must be kept stirred until well incorporated. Pour the mixture into a basin of cold water, and, when nearly cold, it should be pressed, and rolled with the hand until all the water is discharged, then make into a ball. Procure a piece of worn silk, without holes; double it; place the ball therein, and tie up the ends with packthread, taking care that the double silk reaches well and tightly over the ball; cut off the surplus silk, and let the knot remain for a hand-hold.

Dabber.—Take a piece of silk, twice the size of that for the ground ball; double it; place in it a ball of coarse wool well picked out, about the size of a small apple; tie it up in the same way as the ball for the ground, and it is ready for use.

Oil-Rubber.—An oil-rubber is made from a strip of woollen cloth, about 2 inches wide, rolled up tightly, and bound over with packthread or thin tape. With

a sharp knife cut off one end, avoiding the string, so that the surface may be quite flat. This is used for taking out stains, or polishing the plate, as in Fig. 46.

FIG. 46.



Rotten-stone. — Take a piece of fine flannel, rather less than the silk which covers the etching-ground ball; double it; place on it a small quantity of rotten-stone, in powder, which tie up in a bag. A small portion of fine whiting in the lump should be also kept at hand.

Smoking Taper, or Lamp.—For small plates, procure a wax taper; uncoil it by degrees before the fire until it is all equally pliant; double it up in about six lengths; give it one twist while warm, and turn it a few times before the fire, that the pieces of taper may adhere to each other; melt the wax at one end, so that the wick is exposed; see that all the cotton ends will light freely; care should be taken to extinguish the cotton, or it will revive with the least draught, and may become dangerous. For large plates it is preferable to use an ordinary oil lamp mounted on gimbals; this obviates the inconvenience occasioned by the dripping of the tapers.

Bordering Wax.— 3 oz. of resin, 2 oz. of beeswax, and such a quantity of sweet oil as will soften the mixture to fancy. Procure an earthen pipkin; place in the bottom ½ oz. or more of sweet oil; add the resin and beeswax, broken in small pieces; when melted work the ingredients well together with a stick until thoroughly incorporated; then pour into a basin of cold water; as it gets cold, work it well with the hands by pulling out into lengths and doubling it together again; the more it is worked the better it will be for use. Should it turn out brittle, return it broken to the pipkin, and add more oil; work it well together as before, pour it into water, and work it again with the hands.

Engraver's Shade. — Bend a piece of wire into a half circle; bind it together with waxed string; lay it on tissue paper; cut away all but ½ an inch round the wire: cover that ½ inch with paste, and turn it over the wire; when dry the shade is complete. Fasten a light string to the centre of the half-circle, and suspend it from the window-latch when in use. This shade must be placed in a forward position, sloping before the plate, and the white light it produces will enable the engraver to see the lines made by the etching needle. An equally effective shade may be made by covering a light square wire frame with tissue paper, and supporting it with two struts. This frame can be made to rest at any angle, upon the table immediately in front of the work.

Hand-Rest.—Any flat and thin piece of wood will answer the purpose, which is to keep the hand clear of the plate whilst at work. A good hand-rest may be made of a thin board raised above the work upon side pieces of such a height as to allow the plate to be freely moved underneath the board. The front edge of the board may be faced with a strip of steel planed true when it serves as a straight-edge. This arrangement will be found extremely handy.

Stopping - out Varnish. — Turpentine varnish is superior, for several reasons, to Brunswick black.

Turpentine Varnish.—Break small pieces of resin into a phial; pour over spirits of turpentine to about twice the height of the resin. Place the bottle in a small saucepan of water on the hob, near enough to the fire to make and keep the water hot; place a cork lightly in the mouth of the bottle, as the mixture will require to be shaken occasionally. Pour a small portion of this mixture into a small pot, with a little lampblack added to give it a colour, and well mixed. This last is necessary to prevent lumps; it may be done by working the mixture well together with the camel-hair pencil. This is a good stopping-out varnish. With this varnish go over the border or margin of your plate; do this when about to put it away, and the varnish will become hard by being left a night to set. When biting-in

again, go over the margin, using the same brush and mixture. It can always be worked up by adding a little turpentine. When it is set so hard that the finger may be placed on it without sticking, it is time to make up the wall or border of wax to hold the aquafortis.

Aquafortis.—Procure three half-pint bottles with glass stoppers, and two pint earthen jugs with spouts. Place ½ lb. of nitric acid in bottle No. 1. Pour into bottle No. 2 rather less than the fourth of the nitre; fill the bottle three-parts full of water; slowly pass it into one of your pint jugs, and back again to the bottle, to mix it well. In bottle No. 3 put one-half of the remaining nitric acid; water it as before; see that the nitric acid in bottle No. 1 is well stoppered, and cover it with a piece of old glove.

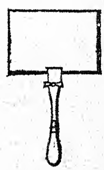
Tracing and Tracing Paper.—Tracing can be conveniently effected by using sheets of transparent gelatine, similar to that made for Heliotype purposes, and placing it over the drawing, which can be seen clearly through the gelatine. Trace with a sharp etching-needle, taking care to remove the burr from the lines with the thumb-nail as the work proceeds. When finished, fill in with fine powdered Brunswick black, entirely free from grease, or powdered red chalk, reverse on to the plate, and rub the lines with a burnisher. Tracing paper of various qualities may be readily purchased. But in case of necessity, very good tracing paper may be made by saturating, with a camel-hair pencil, the finest tissue paper with the following mixture;—½ oz. of balsam of Canada, to ¼ oz. of spirits of turpentine; shake well together in a 2-oz. bottle. When covered with the mixture, hang the paper on a line to dry; then wash in like manner the other side. Place your drawing on a tracing board, a piece of soft planed deal; lay the tracing paper over it; fasten down with brass-headed points, not through the drawing, but close to it, so that the pressure of the brass head secures both the drawing and tracing paper from moving. Go carefully over all the lines of your drawing with an H pencil, occasionally placing a piece of white paper between the drawing and the tracing paper to ascertain that no lines on the drawing have escaped attention.

Transferring Paper.—This is made as follows;—Take half a sheet of very fine bank-post paper; lay it on a clean place, and rub it well with the scrapings of red chalk with a small piece of sponge. Apply the chalk until the paper is all of one colour; then, with a piece of clean old muslin, rub the greater part of the colour from the surface. The colour may be renewed occasionally as the markings become faint.

Testing the Ground.—Heat one corner of your plate, and rub over it the ground in a thin and even surface. Next apply your dabber, to make a yet more equal distribution of the ground. When cold, mark over it with rather a blunt needle (No. 3). Should the ground be brittle, and crack with the passage of the needle, add to it more beeswax; should it drag with the needle, add more asphaltum; the ground will easily melt again. When a ball is satisfactorily made it will last a long time. The weather has considerable effect on the mixture, and the quality of the ingredients is very important, so that it is advisable to get the ground as perfect as possible while the melting pot is in use.

Heating the Plate for Ground.—Have a small hand-vice, Fig. 47, with a haft of wood to resist the passage of heat to the hand. If the plate is stained or discoloured, the mark must be removed with the oil-rubber with a little rotten-stone and oil, polished off with a bit of old muslin powdered with whiting, care being taken that no dust remains on the plate.

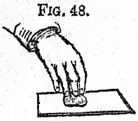
Fig. 47.



Screw the vice on the long side of the copper plate with a slight hold, covering the part grasped by the jaws of the vice with a small piece of paper to prevent injury to the surface. Heating may be performed by burning paper under the back of the plate; but a stove or clear

fire is preferable, and a couple of spirit lamps with rests for the corners of the plate, the best plan of all. Be careful not to overheat the plate. If the surface becomes discoloured the plate is over hot; as a test, turn it over and spit on the back; if the moisture jumps off, the plate is sufficiently hot; should it hiss and remain on the plate, more heat must be obtained. A piece of canvas, rather larger than the plate, should be warmed by laying it before the fire during the heating process; place it on the table, and lay upon it the plate retained in the vice. Now pass the ball of ground, Fig. 48, over it backwards and forwards until the plate is covered, spreading the ground as evenly and thinly as possible. Use the dabber with a quick action, pressing it down and plucking it up. If the ground does not distribute itself easily, burn paper under the plate as before until it shines all over, being cautious that the ashes of the paper do not settle on the surface; dab on again, decreasing the pressure, but not the speed of action, until the surface is all over alike.

FIG. 48.



Smoking the Plate.—Have the taper ready, and a single taper or candle to take the light from; the surface of the plate being perfectly covered, it may be as well to renew the heat in the plate, by a paper burnt under the back until the surface shines, taking the same precautions as before. Hold the plate in the left hand, with the face downward; light the smoking taper, Fig. 49, at the same time, having all the wicks burning; pass it rather quickly round the margin, and by degrees towards the centre, using a fluttering action with the hand, Fig. 50; smoke on until the whole surface is of a dark colour, keeping the taper at such a distance from the plate that the burning cotton may have no chance of touching it, although the flame spreads over it. Another way is to suspend the plate, if of large size, overhead, and smoke with the oil lamp. When the surface is all black alike, and no sooty marks are to be seen on the working part of the plate, the ground is fit for use. Take the plate, face downwards, to some convenient place, and pour cold water over the back, Fig. 51, holding the plate in a sloping position, the vice up. This last process produces a stronger and harder surface than could be obtained if the plate were left gradually to cool. Now place the plate face downwards, supported on one side by the screw of the vice, Fig. 52. Clean the smoke from the back, and let it remain until quite cold. Some difficulty may be found in laying the first ground with success, but with a little practice this is surmounted.

FIG. 49.

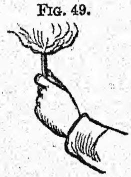


FIG. 50.

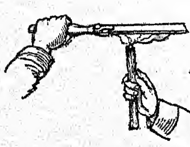


FIG. 51.

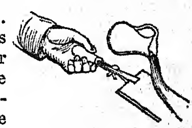
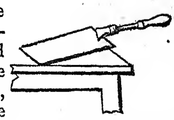


FIG. 52.



Transferring.—In the absence of an etching board, place the copper plate on a thick piece of brown paper larger than the plate; make two ribs of the same paper, doubled four or more times, and about an inch wide; place them at each end of the plate on the brown paper, and fasten them with sealing wax; these ribs serve as shoulders for the rest to lay on, which will prevent the hand from touching the work. Now cut the tracing paper to the size of the plate, having ruled the margin line if one is required. Place the tracing reversed; that is, with the pencil side to the plate. Fix it with pieces of soft wax round the border, leaving open the bottom to admit the transfer paper, which introduce with the chalk side next to the plate; the upper

side of the paper must be kept clean, that the pencil-lines on the tracing paper may be seen. With an H H pencil, cut sharp and short, go over all the lines of the tracing with rather an upright hand and a strong pressure; the upper side of the tracing paper will show whether all the lines have been traced; look sideways at the work, and the black-lead marks will be perceptible. Before advancing far in the transfer, lift up the bottom of the tracing to ascertain if the lines are of sufficient strength; if not, apply more red chalk to the transfer paper. When the transfer is nearly completed, do not take off the whole of the paper, but let the top part remain fixed. Then lift up the tracing, and if any part of it has been neglected, it can again be fixed down, and the omission rectified.

Etching. — Commence with a fine-pointed needle, No. 1, and go carefully over the outline, not making much impression on the copper, but sufficient to remove the ground; with the same point go over all the lighter parts, increasing the pressure, so as to make a slight indentation on the plate. No. 2 point may now be used to go over the lighter shade, with an increased weight of hand. No. 2 point will answer for the darker shades by making the lines nearer together and increasing the pressure. Interline parts that require extra colour with No. 1 point; the etching may be worked at for a considerable time by interlining and dotting. If there are any marks to expunge, dip a pointed camel-hair pencil into the turpentine bottle, and with its point work up some of the ground on the margin of the plate, and therewith stop out the objectionable marks. When set it will resist the aquafortis.

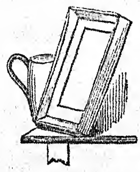
Bordering the Plate.—In cold weather the wax will be too hard to roll out with the hand; in that case it must be placed in moderately warm water until it becomes pliable; then pull and roll it out, Fig. 53, to about the thickness of a small walking-stick; slightly grease the point of the thumb and two forefingers with deer or mutton fat; press the roll of wax flat, and place it on the border of the plate with the edge to the varnish, taking great care that the bordering wax does not go off the varnish. At the parts intended to be the darkest corner of the plate pinch out the wax border, that the height of the wall may be increased at that corner where the spout is to be formed with the wax to prevent spilling the aquafortis in pouring it off.

FIG. 53.

Biting-in.—Lay the plate flat on a piece of canvas larger than the plate as a protection from any splashings that may be made. Place the spout of the plate in front for the convenience of pouring off. Pour a little water over the plate to see if there are any leaks in your border; if there are any, pour off the water; let the plate dry, particularly in the defective part; then press down the outer edge of the wax with a piece of wood. Leaks can also be found without using water by holding the plate up to the light and looking at the edge, when the smallest pin-hole will be immediately detected. Have two or three small wedges, to be used for tilting the plate should the acid not lay even. When the border is sound pour off the water; then cover the surface of the plate with the aquafortis from No. 2 bottle. If, in the course of half a minute, the etching on the plate should assume a light-grey coating, the mixture is good; but if it should throw up bubbles, it is over strong, and more water must be added, but not on the plate. The mixture must be placed in the jug, then in the bottle, and afterwards returned to the plate. Should the lines on the plate remain as bright copper after the acid has been on half a minute, it is not strong enough, and some aquafortis out of bottle No. 3 must be added. When the mixture on the lines does not produce a foam, but the plate continues of a grey, frosty appearance, the process is going on well. The power of biting-in correctly depends on the experience in using the acid. With a soft camel-hair pencil lightly remove the frosty appearance, taking care that the quill does not touch the ground. Should any part of the

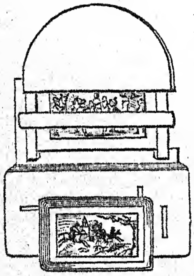
ground break up by the lines becoming united, pour off the acid carefully into the jug. Lay the plate again on the flat, and cover it with water from the other jug, moving it gently with the camel-hair pencil, which place at once in a water-jug when taken from the acid, or it will soon be destroyed. Throw away the wash-water from the plate. When the first biting is completed set the plate up endways to dry, Fig. 54.

FIG. 54.



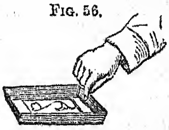
Second Biting.—When the plate is perfectly dry, take off with a blunt point covered with silk and dipped in turps a spot of ground in the lighter part to ascertain if the acid has made sufficient indentation. If it has, work up the stopping-out varnish with a camel-hair pencil, and with it cover all the parts intended to remain light; elevate the rest, Fig. 55, so as not to press the border wax. When the stopping-out varnish is dry, which may be ascertained by placing the finger on it; if it does not stick, it is dry; put on the same aquafortis (bottle No. 2), and let it remain until you observe the ground giving way; then pour off the acid, and wash well as before. Put the plate to drain. Should it be required, more biting may be done; the process is the same.

FIG. 55.



Cleaning Off.—Great care must be taken that the plate is perfectly dry; if it is not it may be placed before the fire, but not close enough to melt the wax. Having carefully wiped the canvas, lay the plate a little more than half-way upon it, so that the balance remains upon the table. Apply a lighted taper, or a folded paper match, progressively under the wax; pull up the wax, Fig. 56, as the warmth proceeds; a very slight warmth answers the purpose. By removing the wax with a knife you are liable to injure the margin, which is difficult to remedy.

FIG. 56.



Should any of the wax adhere to the plate, remove it by using a piece of wood cut in the shape of a chisel. Fix the vice on the same place as when laying on the ground. Rub the plate over with turps, taking care to go over every part; hold the plate up by the vice; heat the back with burning paper as before, until the ground varnish and tallow are melted. Rub off with a soft rag. Should any smut remain, apply a little turpentine; withdraw the vice, and wash the spot it covered with turpentine. Rub the plate front, back, and sides with the rag. Dab the plate with the bag of rotten-stone; pour on it a little sweet oil; and polish the plate with oil-rubber, using considerable up-and-down pressure; wipe the plate quite clean, and polish with fine whiting. Should the biting-in have succeeded, the plate is ready for the printer.

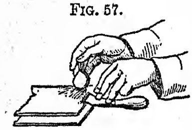
Dry Point.—The dry point may next be used. For this purpose the needle No. 3, well pointed, may be employed, as indenture must be made by pressure of the hand. For interlining the parts which are too weak, and uniting lines neglected in the etching, the dry point will be sufficient; but the pressure will leave a projection or burr on the plate, which must be carefully removed by the sharp scraper; should the plate require more than the dry point can accomplish, recourse must be had to re-biting.

Re-biting.—Heat the plate as before, but make one corner, the one with the least work in it, hotter than the other part. Prior to laying the ground the plate should be polished with whiting, or with methylated spirit and aquafortis, using a piece of old muslin folded in the shape of a dabber, which will fill the etched lines, and prevent the new-laid

ground from entering. Rub the ground on the hot corner, and with the dabber take the ground therefrom, and dab quickly over the other part until the whole surface is covered. All the parts but those wanting more colour may be stopped out as before; the border wax must again be used. Next follow the same process with the acid.

Re-etching.—This is the most certain method of finishing the plate. The ground must be laid as in the first instance, but using a greater body, and with the dabber, Fig. 57 rubbing it well into the lines, taking care that no whiting remains in the etching marks; for this process the plate should be merely washed with turpentine; a slight extra warmth and good dabbing will render the ground acid proof. The smoking is here dispensed with. Set up the ground, and work at the plate as in the first instance. Now use No. 3 sharp point, and interline the parts that should be darker and where greater strength is wanted, crossing the lines, not at right angles, but lozenge-ways. The plate cleaned off as before directed, receiving a light oil rubbing with a little rotten-stone, and washed off with turpentine, may now be sent to the printer's, and a proof obtained. By repeating the re-etching the plate may be worked up to the colour of a line engraving. In some of the darker parts a graver or lozenge-tool may be used; but it is rather dangerous in the hands of the uninitiated; as it is apt to slip, and make deep lines where none are wanted. Re-biting will produce any extra colour that may be wanted with little more trouble and with greater safety.

FIG. 57.



ETCHING.—PROCESS AVOIDING STOPPING-OUT.—For the first biting, ground and smoke the plate in the ordinary manner, then etch those parts only which are to be darkest, such as vigorous foreground in landscapes, and other deep work. Use no delicate lines at this stage; japan the back of the plate and the spot where the hand-vice was placed; use a photographer's tray as an acid bath, in which immerse the plate in nitric acid until the very black lines are bitten-in. Clean the plate, and take a proof. For the second biting, ground the plate again, and smoke it; the first lines will still clearly show. Draw all the work of a medium darkness, with a sharper point than that used for the first biting-in. Place the plate in the acid bath, and let it remain until the lines are of a moderate depth. Remove and clean the plate, and take a second proof. For the third biting, ground with transparent ground, and do not smoke it. Etch all the delicate work, keeping the lines close to each other, and using a sharper needle than before. This operation requires more care than the two previous ones, as the lines will not show very distinctly. This process is of great service for intricate work, in consequence of the ease it gives of introducing pale lines amongst the darker work, and a delicate background beyond the vigorous lines of the subject; whilst, by taking proofs after each biting, the progress of the work may be seen, and its correctness ensured. By covering the back and edges of the plate with japan varnish, the old and tedious process of banking up the sides with wax is avoided, and the plate may be plunged into the acid bath without any further risk or trouble.

ETCHING.—GENERAL INSTRUCTIONS.—The following directions will relieve beginners from much trouble, and enable them to avoid many accidents to which engravers are liable;—when using the acid, slightly grease that part of the hand likely to come in contact with it, as a preventive to its making stains, which are not easily eradicated. When your border wax has done its duty, have it well washed in cold water, then warmed before the fire, pulled out and pressed together again, as the more frequently that is done the more pliable the wax will be for future use. As your aquafortis will become reduced in strength by exposure to the air, it becomes necessary to add a portion of No. 3 bottle to that of No. 2, and a small quantity of

No. 1 bottle to No. 3, No. 1 bottle containing the undilute acid. When making a point to an etching needle, work the point round, as, should there be any flat side to the point, it will bite the copper, and prevent the freedom of hand required to give spirit to the etching. The burnisher will soften down any part of the etching that appears harsh or crude, by gently passing it over the parts to be reduced in colour. The shade must be between the plate and the light, in order to be able to see the marks of the burnisher; fine charcoal and oil will remove these marks, and the oil-rubber will clear away the charcoal marks. The charcoal can be obtained at a coppersmith's or plate-printer's. If a burnisher is good at first, it never requires alteration. The scraper must be occasionally sharpened.

Soft Ground.—Take half a ball of hard ground, mixed as described under the head *Etching Ground;* to that add a piece of mutton suet. Melt them well together, observing that the ingredients must be thoroughly incorporated; then pour into cold water, and use it as before directed.

Laying the Ground.—The process is exactly the same as in laying the etching ground, with this difference, that the plate does not require so great a heat. Smoke the plate the same as in laying etching ground. The ground must be spread as thinly as possible, to cover the plate and bear smoking. The surface of the plate must be alike all over, and quite bright or shining. If any part but the edges appears sooty, it must be cleared off and the plate polished, as described for etching, and laid again. A good ground may be made at the first melting, but that can scarcely be expected. It may be as well to test the quality of the mixture before laying a whole ground. To this end, heat a small portion of the plate; lay on the ground; smoke it; and let it get quite cold. Obtain some of the finest tissue paper, of very even texture. Place a piece of the paper on the patch of ground laid, and, with a fine-pointed H pencil, make a slight sketch;—a bit of foliage, for instance; the paper should slightly stick to the plate; when carefully raised by the two bottom corners, the back of it should clearly show every line made on its surface, only darker. Should the sketch on the copper look as if it was dotted all over, the mixture of ground will do. Should the ground adhere to the paper, like marks with pen and ink, the ground must be melted, with an addition of hard ground; and if even the softest marks of the pencil do not pull the ground from the plate, the ground must be remelted and remixed until it is fit for work. As the temperature has great effect on this ground, that which will answer for summer will not do for winter, so it may be as well to make two or three mixtures, and number them according to their several degrees of hardness. Having succeeded in mixing the ground, take a piece of tissue paper twice the size of the plate. Place the plate in the centre, and with a black-lead pencil draw a line all round it. Make the same mark on the other side; then lay the ground as described. When cold, wipe the back and edges before taking off the hand-vice. This ground being very tender, care must be taken not to touch the face of the plate.

Drawing.—The drawing is to be made upon the square marked on the paper. If it is intended to copy a subject, the same process as in transferring for the hard-ground etching is used; only, instead of transferring the red lines on to the plate, they must be made within the square marked on the paper. Take care that the tracing is reversed. If it is intended to draw on the plate without copy, lightly make the design on the square marked with fine-pointed red chalk. Should the subject be figures, everything must be drawn to the left hand, or reversed. Fold a silk handkerchief in four; lay it flat and smooth on the table; place on it the paper, with the chalk sketch downwards. Then, with great care, lay the plate, face down, exactly on the square mark of the paper; fold over the back the surplus paper, and fix the sides with four thin spots of sealing wax near the corners; be sure

not to move the plate on the silk. Take up the plate carefully, and place it for work. Use a hand-rest, as in etching, and a hard-pencil, H H, on the places you wish to be dark. In soft-ground engraving, the drawing must be finished the day it is commenced; the mechanical part of the work may be delayed. When the drawing is finished, pull up the paper by the two bottom corners. Varnish the border down the same as in etching. The acid used must be much stronger; the border wax higher and broader in the spout, as you may perhaps have to pour off suddenly.

Biting-in.—In biting-in, pour off the acid when the ground begins to break up; that is, coming up in patches. During the biting-in the soft camel-hair pencil may be used, but very tenderly. Wash well off with cold water, and place the plate to dry. For cleaning, see *Etching.* Should the plate require more finishing, have recourse to the hard ground without smoking.

AQUA-TINTA ENGRAVING.—This was formerly resorted to where the object was to produce a plate, the impressions from which were to be coloured. It is recognized by its similarity to Indian ink or sepia drawing; for, in working the plate at press, black and brown inks are used indifferently, as the artist or publisher may direct. Resin forms the ground in this method of engraving.

Aqua-tint Ground.—Break some of the best white resin into pieces, and put into a bottle with spirits of wine, and shake occasionally until the resin is dissolved. The bottles must have corks, not glass stoppers. Have two other bottles ready; mark the bottles 1, 2, 3. No. 1 is the bottle into which the resin is placed. Pour a third of No. 1 into No. 2, and nearly fill it with spirits of wine. Pour into No. 3 rather less of the mixture from No. 1, and nearly fill it with spirits of wine. These bottles must be occasionally shaken, and their contents allowed to settle well before use. The contents of the three bottles must be so mixed that they are one under the other in strength, as the size of the grain to be laid on the plate depends on the quantity of resin each mixture contains. The more of resin the larger the grain. The spirits should be entirely free from water.

To Test the Spirits.—Place a small quantity of gunpowder in a silver spoon; pour over it some of the spirit; light the spirit, and let it burn to the powder. If the powder takes fire and explodes, the spirit is good, and fit for use. Should it remain in the bottom of the spoon, black and wet, the spirit has been adulterated with water, and is not fit for the purpose.

Trial of Aqua-tinta Ground.—Have a tin trough about 2 inches wide, and rather longer than the plate, with a convenient spout at one end; the trough is to act as a receiver of the spirit when poured over the plate; the spout to return it to the bottle.

Laying the Ground.—Polish the plate well, as before directed. Place it at a slight slope, the tin trough under the lower edge to receive the spare mixture. As a trial of the ground, pour the liquid from each bottle, and make a small patch in different places at the bottom of the plate. When the liquid has run off into the tin trough, lay the plate flat, and with a piece of rag wipe the lower edge. Take a magnifying glass, and look at the grains deposited on the copper. Having poured the spirit from the trough to bottle No. 1, make choice of the grain most likely to suit the work; if neither of the three should, mix the large grain and the small together until it does, letting the mixture settle well before it is used. Remove the trial spots; polish the plate well, and place it as directed for trial with the side intended for the foreground next to the tin trough. Pour the mixture along the top of the plate, from one end to the other, until the whole of the surface is covered. As soon as the spirit has run into the tin, lay the plate flat; the sooner it is laid flat the rounder will be the setting of the grain; the longer the plate remains on the slope the more elongated the deposit of resin will become, which for some sort of work will answer better than round; such as broken rock, waterfalls. In most cases it is advisable to make a very fine etching of the subject intended to be placed on

the plate prior to laying the aqua-tinta ground; in the end it will save time. The etching must be very light, otherwise the aqua-tinta ground will hang round the lines, and form a ray of light. Should the etching be strong, it will require to be filled up with wax, and polished off before laying the ground. Engravers send the plate to the printer's to have it filled up with ink, which is the best method. If obliged to use wax, heat the plate rather above what is required for the etching ground, the surface wiped off, and polished with the soft part of the hand slightly rubbed with whiting.

Stopping-out the Lights.—Place on the left side a small looking-glass in a leaning-forward position; lay before it the drawing intended to be worked from, with the base or foreground towards the bottom of the glass; you will then see the subject reversed in the glass. Go over the margin as directed in the head Etching. For this a camel-hair pencil and the same pot of varnish, with a little more lampblack added, and well worked together, should be used. Stop out all the white lights seen in the drawing. By the time this is done the varnish on the margin will be dry or set; if not, the plate must remain until it is. Go over the margin again with the same varnish, and let that set hard. Place your border wax as before directed, making the spout rather larger, that you may be enabled to pour off the acid quickly if necessary. Use the same aquafortis as for etching, but the strength somewhat increased, as it must remain on the plate a much shorter time. Lay the plate an inch or so over the front of the table, with a piece of canvas underneath, having small wedges of wood ready to be used should the acid not float evenly.

First Lights.—Pour on the acid rather quickly, running it from the bottle to the jug, then on to the plate; another jug, having been filled with cold water, should be kept ready for washing off. When the acid has entirely covered the plate, the surface should immediately assume a frosty appearance, but not come up in bladders. Little more than a minute may be enough for the acid to remain on the plate; pour it into the jug as quickly as you can without spilling it; immediately wash off with cold water; have a receiver for the wash-water, as it must be thrown away.

Second Lights.—Dry the surface of the plate, and, should any spots of moisture remain on the surface, carefully take them up with blotting paper. Now, with the same varnish, stop out all the second lights. To prevent injury to the border, place two blocks or old books under the ends of your rest.

Third Lights.—When the second stopping-out is set, put the plate through the same process with the same acid. Again dry the plate, and stop out the third light parts; when set, apply the acid, but let it remain on rather longer; wash as before directed. As all the flat tints are now laid, it only requires the very dark ones. Ascertain, with a magnifying glass, if the spots of resin remain on the plate; if so, it will bear biting again. Should the ground remain sound enough to stand another application of the nitre, you must prepare a mixture called touching stuff.

Touching Stuff.—Burn a good-sized cork to ashes; take some treacle and add as much ivory black as will make the mixture a dark colour by the addition of a small quantity of sheep's or ox gall; it works almost as free as the varnish. Make the composition into a ball, a small quantity to be used with water when required. Again lay the plate for work. Paint over all parts that are required to be very dark, such as projecting foliage, and all sharp shadows, with the touching stuff, loading all the touches with as much of the mixture as can be placed on them. When the touching stuff is dry, mix some turpentine varnish, slightly coloured with lampblack, and with a larger brush go over the whole of the plate. When this last varnish is set, pour on some very weak acid and water; the former washings of the plate will do. With the soft camel-hair pencil used for the acid, work up the touching stuff until the whole comes off; then wash the plate clean with cold water, and again apply

the acid. For this last biting the acid may remain on the plate as long as the ground will stand. This may be ascertained by clearing the plate with the camel-hair pencil, and using the magnifying glass. The plate must now be cleaned, and remove the border wax as before described. On this tint the oil-rubber should be very carefully used. The plate being quite clean, and placed under the shade, it will be found that the tints or bitings are rather sharper against each other than is required. The burnisher will remove this by rubbing the parts which are to be reduced in colour. The parts to be burnished should be slightly touched with the oil-rubber. The use of the burnisher requires some skill, which can only be acquired by practice. The scraper is useful for bringing out sharp lights, and modulating the darker parts. If the first ground is not satisfactory, the plate must be polished, and another ground laid. The second ground must contain more resin than the first; bordering, biting, and stopping-out as before. The plate should be sent for proof before the second ground is laid. The proof will show where increase and where reduction of colour is required. The burnisher will reduce; the increase can only be had by laying another ground.

Ground to Etch on.—Mix a small quantity of turpentine varnish with turpentine slightly coloured with black, but only sufficiently so as to render the lines made by the needle perceptible. With this thin varnish, and a good-sized camel-hair brush, go over the plate lengthways; when that is set, repeat the coating crossways; let it set, and lay it by for a night if convenient. The etching finished, border and bite as before directed, but with stronger acid.

Aqua-tint Engraving. — General Instructions. — Great care must be taken while laying the ground that there is not much dust floating in the air; for, should the slightest particle of flock lodge on the plate whilst wet, it will cause what is called an accident. Wherever the speck falls the resin will corrode around it, forming a white spot on the ground where the acid has been applied. These accidents are of little consequence, unless they should happen on the sky. To do away with these light places, the chalk tool, or dotter, must be used; this is simply a bent graver. From pouring the ground mixture backwards and forwards, it is likely to become foul; it should then be passed through a double piece of clean muslin, and put away in a bottle to settle. The burnisher acts as principal in forming a good sky and background. As the action of the acid will leave all the tints with a sharp edge, they must be softened down with the burnisher. Every fresh aqua-tinta ground laid should be increased in the size of the grain, or the ground will become murky. To enrich and darken the foreground and foliage, etching over the parts with the etching ground above described is much the easiest method.

Resin-ground Engraving.—This is well adapted to ornamental work, as great depth of colour can be obtained. The process is extremely simple. The best white resin should be reduced to powder by pestle and mortar, then placed in fine doubled flannel, and tied up in a bag. The plate must be heated as in laying etching ground, and the resin then powdered on the surface; lay the plate on a table, so as to leave both hands free. Take the bag of resin in the right hand, and strike it against the left, the bag must be held some distance from the plate, which will force the powdered resin to escape from the flannel bag, and, falling on the hot plate, will there fix itself in small spots, something similar to the aqua-tint deposit, but much more enduring. This produces very imperfect results and causes dry ground engravings to be looked on with disfavour. The stopping-out process is the same as in the aqua-tint. By repeating the process with the flannel bag, a positive black ground may be procured, as dark and more enduring than a mezzo-tinto ground, and it may be scraped on much in the same way.

Hamerton's Brush Process.— This process consists in the employment of a pigment which is strongly attacked by acid. Clean the plate thoroughly with

whiting and turpentine. Remove the whiting by rubbing the plate with bread; after removing which do not allow the hands to touch the plate. Crush a soft pastel into fine powder; mix with a strong solution of white sugar. Add a solution of ox-gall, about equal in quantity to half the sugar solution. The pigment must be so mixed as to work rather freely, and draw a thin line with ease and precision. With a small, fine-pointed sable-hair brush, make the drawing on the plate, depending mainly upon lines, as with a pen; when this is completed, be careful not to let anything touch the plate, as the pigment dries slowly. Dissolve some ordinary etching ground in ether; hold the plate with a pneumatic holder, and pour the solution upon the plate till it makes a pool reaching the sides of the plate; move the plate gently from side to side, then pour the superfluous solution back into the bottle. Heat the plate gently over a spirit lamp, holding it about 12 inches above the flame, and taking care to evaporate the ether gradually, and not to allow it to catch fire. The ground will become transparent. Place the plate in a bath consisting of hydrochloric acid, 100 grammes; chlorate of potash, 20 grammes; water, 880 grammes. The hydrochloric acid used should not be of a deep yellow colour; should not give off fumes, and, when mixed with water, should have but a slight odour. Leave the plate in this bath a quarter of an hour, then brush the surface of the plate very gently with a feather. This will remove the pigment and the ether varnish over it, leaving the lines exposed to the acid. The copper between them will be perfectly protected. Leave the plate in the bath until bitten-in to the required depth, stopping-out when necessary. The finer portions of the work may either be finished with the dry point, or in point etching; in the latter case using a transparent ground. If any erasing is necessary, it must be done with a scraper. If the pigment does not take on the plate, the copper may be slightly roughened by a short immersion in a weak nitric bath. Let the ether ground remain a night on the copper before heating it, which must be very carefully done.

Hamerton's Negative Process.—This process avoids stopping-out altogether, and the progress of the work may be judged of with tolerable certainty. The ground is a solution of beeswax in turpentine. Decant the solution till no sediment remains; it should be perfectly fluid, and of a bright yellow colour. Add about one-sixth of its volume of japan varnish; this quantity will vary slightly according to the heat of the weather. If there is too much japan, the ground will be hard and brittle; if there is too little, it will not be strong enough to take smoke with safety. Clean the plate with engravers' emery paper, and place it in a bath of hydrochloric acid, 100 grammes; chlorate of potash, 20 grammes; water, 880 grammes. When the plate darkens all over, it is a sign that there is no grease on it, and it is then ready to receive the ground. Pour on the ground as photographers pour collodion, and let it dry for 12 hours; apply a second coat of ground in the same manner, and smoke the plate immediately without waiting for it to dry. The ground should then be even and smooth, and ought to be used a few days after it is laid, as it hardens in time. If in haste to use the plate, the first coat of ground may be dried over a spirit lamp until it becomes transparent; cool the plate, and proceed as before described. The use of the two coats of ground is to prevent the smoke penetrating to the plate, and causing the ground to become detached in the acid bath. Should the ground be too hard, increase the proportion of the wax solution. Draw all the dark parts first; plunge the plate into a bath of nitric acid for half the time necessary to complete the biting. In temperate weather this would be half an hour; the first biting would, therefore, take about 15 minutes. Remove the plate, dry on blotting paper, draw the next darkest lines where required, and replace the plate in the bath for a quarter of the total time. This process is repeated, and the plate, with the paler work, is replaced in the bath for one-eighth of the

total time. The palest work of all is last drawn, and the plate is plunged into the bath for an eighth of the total time. Thus the plate will have had the darkest lines in acid the whole time required, the darker lines half the time, the pale lines a quarter, and the palest lines one-eighth of the times, as each biting-in has the advantage of those which preceded it. Finish with the dry point where required.

Hamerton's Positive Process.—By this process the work is distinctly seen during operation; black on a white or silvered ground, without any deceptive glitter, and exactly as it is to be seen in the print. Clean the copper plate, and rub it with a clean rag and a little of Levi's *crême d'argent*, cyanide of silver. Remove the superfluous cream with a clean rag, and the plate will be properly silvered. If the cream is too thick, add a little spirits of wine. If it is wished to make the silver of a dead white, slightly roughen the surface of the copper before silvering with fine emery paper, rubbed from right to left, or from left to right, of the way it is intended to work the plate. Use a white ground, made by dissolving white wax in ether—a saturated solution. Let it settle a few days; the clear part only is required, the milky portion at the bottom, being undissolved particles, are probably insoluble and useless. To apply this ground, hold the plate underneath with a pneumatic holder; pour the solution on the silvered side; move the plate gently but firmly from side to side, so that the solution may run to and fro; then pour all the superfluous ground back into the bottle. In finishing, move the plate more rapidly. Let the ground dry for 3 days. Apply a second coat in the same manner, and let it dry for 4 days in a quiet room, where it will not catch any dust. If the plate is dried by the heat of a spirit lamp, the ground will be transparent, but not of the dead white colour which is desirable. Paint the back and edges of the plate with japan varnish to protect them in the bath, which must be composed as follows;—Chlorate of potash, 20 grammes; pure hydrochloric acid, 100 grammes; water, 880 grammes; or the same proportions in English weights. Warm the water, dissolve the chlorate of potash in it, then add the acid. Sketch the subject with some pale but decided water colour, red or yellow for example, using the point of a small camel-hair brush. This will remain visible whilst the plate is being etched, which must be done whilst it is in the bath; the acid will, of course, attack the needle, but this action keeps the needles sharp, and they are not costly tools. The bath should be formed in an oblong square piece of light wood, about 1½ inch thick, and larger than the well, which must be a square hole, a little larger than the plate, and about an inch deep. Cover the board and well with about six coats of japan, which protects the wood from the action of the acid, and the dark colour makes the plate look whiter from the contrast. A thin piece of wood, stained black, must be used as a hand-rest. Before using a new bath or well dissolve a small piece each of copper and of zinc in it with acid. Lay the plate in the desired position, and fix it by pressing small pieces of modelling wax at the corners against the plate and the board. Etch with an ordinary strong sewing needle inserted in a holder. It must be sharp enough to scratch well through the silver, otherwise the line will not blacken at once. The wax ground permits the lines to enlarge slowly; thus there is a constant gradation in thickness from the first to the last lines; as the time of exposure diminishes, this property must be carefully attended to. Thus, if the subject requires only about 2 hours' work in etching, this must be spread over 5 hours' exposure in the bath, which is the time necessary to produce the darkest lines; other work can be carried on simultaneously, but this process cannot be hurried. If, however, the subject is elaborate, and requires more etching than can be finished in 5 hours, select for the first sitting various parts over the whole plate; clean and re-ground the plate; at the second sitting add work to that previously done, and so on until the plate is finished, so arranging the times as to work always at the same period of

the operation on tones intended to be of the same depth. This process is acquired with a little practice. If necessary to efface, it may be done in the usual manner with scraper and charcoal; always re-silver before retouching, if retouching is required. For cleaning the plates turpentine is usually employed, but schist-oil or petroleum are better cleansers, and remove the japan varnish very rapidly, whereas turpentine dissolves it slowly.

Etching from Nature.—Etching is the only kind of engraving which can conveniently be done directly from nature. The choice of subjects is the most important point, as, although etching is admirably adapted for trees and vegetation in all its forms, and for picturesque buildings and animals, it is not so well suited for the representation of figures, or for other subjects, which require delicate gradations of tones. For anything that can be expressed by lines, etching is very successful, but it is not easy of application to tones. In working from nature, the shading, in addition to giving the light and dark tints, should also be used to indicate the form and texture of the surface, the lines being drawn in a direction to indicate form as well as tint. Several plates, ready grounded, may be carried in a small grooved box to keep them apart; if only one plate is intended to be used, it can be carried between two light boards, but must not be allowed to touch them. This can be avoided by fixing small pieces of modelling wax at the corners of the plate. If intended to be etched on Hamerton's positive process, the drawing board, with the well in it, must be taken, and the necessary hydrochloric acid and chlorate of potash in two stoppered bottles. These can be mixed with water when required. Dry point is frequently used in the finishing of etched plates. The dry point is an ordinary steel etching needle, sharpened in a peculiar manner with a sharp rounded cutting edge, and used without either etching ground or acid bath. By using this tool on the bare copper, a burr is raised, which catches the ink, and in printing gives the desired effect of a line with a delicate gradation. The more perpendicular the needle is held the less burr there will be raised; by inclining the hand to the right the burr will be increased, if the pressure on the tool remains the same. Practice enables an etcher to regulate the pressure on the tool; but if the pressure used has raised too strong a burr, it can be partially or entirely removed by using a sharp scraper worked at right angles to the line. If it is desired to see the progress of the work rub a mixture of tallow and lampblack over the plate; remove what is superfluous with a soft rag; the effect of the etching can then be fairly judged of. Dry point etching can now be made to give a large number of impressions, by having the plate protected with a coating of steel applied by galvanism. To efface faulty work use sand-papers of several degrees of coarseness; the coarsest first, then the scraper; finally, rub over with willow charcoal and olive oil. This leaves the plate fit to be etched upon; if, however, it should be hollowed out by this process, mark the spot on the back of the plate by means of callipers. Lay the face of the plate on a block of polished steel, and give it two or three blows on the back with a rounded hammer. The engravers' copper planers will do this work with more precision and skill than can easily be acquired by ordinary etchers. A passage that has been over-bitten may be easily reduced by being rubbed with willow charcoal and olive oil, which merely reduces the copper without injuring the lines, except the very pale one; these must be etched over again. It is better to have the plate over-bitten than not enough, as the former is more easily remedied than the latter.

Stippling is also executed on the etching ground by dots instead of lines made with the etching needle, which, according to the intensity of the shadow to be represented, are made thicker and closer. The work is then bit-in.

Etching on Steel is executed much in the same way as in the process on copper. The plate is bedded on common glaziers' putty, and a ground of Brunswick black, or wax, is laid in the usual way, through

which the needle scratches. It is then bitten-in in the way above described.

Etching on Cast Iron.—Use a solution of common salt and sulphate of copper for the biting-in.

Etching on Steel or Iron.—Take sulphate of copper, sulphate of alum, and muriate of soda, of each 2 drachms, and strong acetic acid $1\frac{1}{2}$ *oz.*, mixed together. First smear the part intended to be etched with yellow soap, and write with a quill pen without a *split.*

ETCHING GLASS.—Glass is etched by hydrofluoric acid gas, or by liquid hydrofluoric acid. The acid for this purpose is obtained by treating fluoride of calcium, Derbyshire spar, with sulphuric acid, in a leaden vessel, as we shall presently describe. The gaseous hydrofluoric acid has the property of producing a surface which represents ground glass in its appearance; but the liquid acid produces just the contrary effect, and dissolves away the glass, leaving the surface polished and clear Etching glass, therefore, consists of two operations;—etching by the gas, and producing a dull opaque surface, and etching by the liquid, and producing a surface which is bright and clear. 1. Gaseous hydrofluoric acid is the product of the action of sulphuric acid and fluoride of calcium. Take powdered fluoride of calcium, 2 parts; sulphuric acid, 3 parts. The powdered fluoride is placed in a leaden dish or shallow box, the sulphuric acid poured upon it. By means of a stick, the acid is made into a paste with the powdered fluoride; the mixture only requires to be warmed to evolve considerable fumes of gaseous hydrofluoric acid. These fumes are disagreeable; the experiment should, therefore, be conducted in the open air or under a chimney. The glass plate to be etched is covered with wax, by gently warming the glass sufficient to melt wax, and rubbing it with a piece of white wax until it is covered by a thin layer; it is then allowed to cool, and the waxed surface is etched with a graver. The sheet of glass thus prepared is used as a cover for the leaden vessel containing the materials, with the waxed side presented to the escaping fumes. These fumes will attack the glass where the wax has been removed only, and produce the dull appearance desired. The entire surface of the glass can be rendered ground in its appearance by exposing it to the fumes of the acid gas in its ordinary condition, unprotected by the wax. The production of the gas is accelerated by the warmth of a hob or of a spirit lamp applied to the bottom of the leaden vessel for a few moments. 2. To obtain the liquid acid, place the mixture named above in a leaden retort, and conduct the gas from the retort into a leaden bottle containing some water, so long as the water absorbs the fumes. The water becomes thus highly charged with hydrofluoric acid, and this liquid is to be used in the second process. The glass plates are to be prepared as before, with the addition of a small wall of wax or putty, which is to be formed round its edges; the liquid acid is poured upon the etched waxed surface, and allowed to remain until a sufficient depth of etching is produced. 3. To produce a colourless pattern on a coloured glass ground, you proceed as for etching an ordinary pane of glass, but the operation is conducted upon the surface of flashed glass; that is, glass which is simply covered on one of its sides with a colour, and which is not stained throughout. This flashed glass is a cheap imitation of stained glass; the thin coating of coloured material is soon dissolved by the acid, so as to leave a transparent or ground-glass pattern on a coloured glass ground, according as the process is conducted by means of gaseous or liquid hydrofluoric acid. The acid must be carefully handled, as it attacks the skin and produces stubborn sores, which are not easily healed, and it must be kept in india-rubber bottles, as it will dissolve glass.

Engraving on Copper is performed by cutting lines representing the subject on a copper plate by means of a steel instrument, called a graver, or burin, ending in an unequal-sided pyramidal point. Besides the graver, the other instruments used in the process are a scraper, a burnisher, an oil-stone, and a cushion for supporting the plate. In

cutting the lines on the copper, the graver is pushed forward in the direction required, being held at a small inclination to the plane of the copper. The use of the burnisher is to soften down the lines that are cut too deeply, and for burnishing out scratches in the copper; it is about 3 inches long. The scraper, like the burnisher, is of steel, with three sharp edges to it; it is about 6 inches long, tapering towards the end. Its use is to scrape off the burr raised by the action of the graver. To show the appearance of the work during its progress, and to polish off the burr, engravers use a roll of woollen, or felt, called a rubber, which is used with a little olive-oil. The cushion, which is a leather bag about 9 inches diameter filled with sand, for laying the plate upon, is now rarely used except by writing engravers. For architectural subjects, or for skies, where a series of parallel lines are wanted, a ruling machine is used, which is exceedingly accurate. This is made to act on an etching ground by a point or knife connected with the apparatus, and bit-in with aquafortis in the ordinary way.

Copper Plate.—The plate must be perfectly polished, very level, and free from any imperfection; to this must be transferred an exact copy of the outlines of the drawing. To do this the plate is uniformly heated in an oven or otherwise till it is sufficiently hot to melt white wax, a piece of which is then rubbed over it and allowed to spread, so as to form a thin coat over the whole surface, after which it is left in a horizontal position till the wax and plate are cold. A tracing having been taken of the original design with a black-lead pencil on a piece of thin tracing paper, it is spread over the face of the prepared plate, with the lead lines downwards, and, being secured from slipping, a strong pressure is applied, by which operation the lead lines are nearly removed from the paper, being transferred to the white wax on the plate. The pencil marks on the wax are now traced with a fine steel point, so as just to touch the copper; the wax is then melted off, and a perfect outline will be found on the copper, on which the engraver proceeds to execute his work.

Engraving on Silver or Gold.—1. The engraving is first exposed to the vapour of iodine, which deposits upon the black parts only. The iodized engraving is then applied, with slight pressure, to a plate of silver, or silvered copper, polished in the same manner as daguerreotype plates. The black parts of the engraving which have taken up the iodine part with it to the silver, which is converted into an iodide at those parts opposite to the black parts of the design. The plate is then put in communication with the negative pole of a small battery, and immersed in a saturated solution of sulphate of copper, connected with the positive pole by means of a rod of platinum. Copper will be deposited on the non-iodized parts, corresponding to the white parts of the engraving, of which a perfect representation will thus be obtained; the copper representing the white parts, and the iodized silver the black parts. The plate must be allowed to remain in the bath for only a very short time, for, if left too long, the whole plate would become covered with copper. The plate, after having received the deposit of copper, must be carefully washed, and afterwards immersed in a solution of hyposulphite of soda to dissolve the iodide of silver, which represents the black parts; it is then well washed in distilled water, and dried. 2. Heat a silver plate, previously coated with copper, to a temperature sufficient to oxidize the surface on the copper, which successively assumes different tints, the heating being stopped when a dark-brown colour is obtained. It is then allowed to cool, and the exposed silver is amalgamated—the plate being slightly heated, to facilitate the operation. As the mercury will not combine with the oxide of copper, a design is produced, of which the amalgamated parts represent the black, and the parts of the plate covered with oxide of copper represent the white parts. The amalgamation being complete, the plate is to be covered with three or four thicknesses of gold leaf, and the mercury is evaporated

by heat, the gold only adhering to the black parts. The superfluous gold must then be cleared off with the scratch-brush; after which the oxide of copper is dissolved by a solution of nitrate of silver; and the silver and copper underneath are attacked with dilute nitric acid. Those parts of the design which are protected by the gold, not being attacked, correspond to the black parts of the plate; the other parts, corresponding to the white parts of the engraving, may be sunk to any required depth. When this operation is completed the plate is finished, and may be printed from in the ordinary method of printing from woodcuts.

Line Engraving on Gold.—To obtain from the same prints plates with sunk lines, similar to the ordinary engraved copper-plates, a plate of copper, covered with gold, is operated upon. On immersion in the sulphate of copper solution, the parts corresponding to the white parts of the engraving will become covered with copper. The iodine, or compound of iodine, formed, is then to be removed by the hyposulphite; the layer of deposited copper is oxidized, and the gold amalgamated, which may be removed by means of nitric acid, the oxide of copper being dissolved at the same time. In this instance the original surface of the plate corresponds to the white parts of the print, and the sunk, or engraved, portions to the black parts, as in ordinary copper-plate engravings.

Electro-metallurgy.—The first and most important operation in all branches of the electro-deposition of one metal upon another, is to effect a thorough and chemical cleansing of the surface of the metal upon which the coating is to be deposited.

Cleansing Copper and its Alloys.—This is done in six operations. 1. Cleansing by fire, or by alkalies. 2. Dipping. 3. Dipping in old aquafortis. 4. Dipping in new aquafortis and soot. 5. Dipping in compound acids for a bright or dead lustre. 6. Dipping in nitrate of binoxide of mercury.

Cleansing by Fire, or by Alkalies.—This is to remove any foreign substances, especially those of a fatty nature, which are destroyed by heating the pieces in every direction over a gentle fire of charcoal, breeze, or spent tan. A muffle furnace, heated up to a dull red heat, is preferred; but small articles may be cleansed in a hot revolving cylinder. This operation is not adapted to very delicate articles, or for table-forks and spoons, which must keep their toughness, or to those pieces in which the different parts are united by soft solders. Boil such articles in a solution of potash or soda, which renders the fatty substances soluble in water. This is done in a cast-iron kettle, provided with a cover, where there is a boiling concentrated solution of carbonate of potash, or soda, or of American potash. The caustic potash or soda must be dissolved in ten times its weight of water. This solution lasts a long time; when it has lost part of its power, it may be revived by a few fragments of caustic alkali. At the boiling point it will cleanse copper in a few seconds. If the articles to be scoured are joined with tin solder, they must not be allowed to remain too long in the caustic liquor, which would dissolve the solder and blacken the copper.

Dipping.—The pieces are then dipped in a mixture of from 5 to 20 parts in weight of sulphuric acid at 66° Baume for 100 parts of water. Most of the pieces to be cleansed may be dipped hot in this mixture; but certain alloys, in which tin, zinc, or antimony predominate, such as cast bronze, must not be so treated, as the sudden cooling will occasion cracks and flaws. Copper articles may remain any length of time in the dipping bath; they should not be removed before the black coat of binoxide of copper, caused by the heating, is entirely dissolved. The remaining coat of red protoxide of copper is unacted upon by the sulphuric acid. Articles having parts made of iron or zinc must not be submitted to the action of dilute sulphuric acid, or they will be entirely dissolved; therefore avoid the use of implements or wires of iron, zinc, or steel. A dipping bath which contains copper in solution from previous operations will not suit for articles which may contain iron, tin, tin solder, antimony,

bismuth, or lead. In such a case, use a newly-made dipping bath and a small proportion of acid. Articles which have been cleansed by alkalies must be washed before being put into the dipping bath, or pickle. Thoroughly and rapidly rinsing in fresh water all the articles, before and after each of the following operations, must be strictly attended to. The various manipulations which complete the cleansing succeed each other without interruption; and the articles must be stirred as well as possible in the acid baths, and in the rinsing water. After dipping and rinsing, the various pieces are fixed to a brass wire, or hooked upon brass or copper hooks. Small articles of jewellery are suspended to a stout copper wire. These hooks are better if made of pure copper than of brass, and it is still better to use glass hooks, which are cheap and are not corroded by the acids. Such hooks or supports can be made by bending glass rods, by the heat of a charcoal fire, or of a gas burner, to the desired shape. Those objects which cannot be suspended or attached to hooks, are put into perforated ladles of porcelain or stoneware. It is less economical, but sometimes absolutely necessary, to use baskets of brass or copper wire cloth. Those who frequently have to cleanse very small articles will find it advantageous to employ a basket of platinum wire cloth, which, although expensive in the first cost, will be found cheaper in the end, as it is almost indestructible.

Dipping in old Aquafortis.—If there is any aquafortis, nitric acid, already weakened by preceding dippings, plunge into it the articles which have passed through the sulphuric acid pickle bath, and have been rinsed. They may remain there until the red coat of protoxide of copper has entirely disappeared, leaving, after rinsing, a uniform metallic lustre. The dipping in old aquafortis, though not absolutely necessary, is recommended for two reasons; it economizes the cost of fresh acids; and, as its action is slow, it prevents the too rapid corrosion of the cleansed copper during the time of the solution of the protoxide.

Dipping in Aquafortis and Soot.—After rinsing in fresh water, the articles are well shaken and drained, and then plunged into a bath composed of nitric acid at 36° Baumé, 100 parts; common salt, 1 part; calcined soot, 1 part. This mixture attacks the metal with the greatest energy, and the pieces should therefore not remain in it more than a few seconds. The volume of acid should be about 30 times that of the articles to be cleaned, in order to prevent too great an elevation of temperature due to the chemical reaction, which would result in the rapid weakening of the acid. After this bath, and rapid rinsing, in order to prevent the production of nitrous vapours the pieces present a fine red lustre, gold yellow or greenish yellow, according to the alloy employed, and such as to make one believe that they are entirely cleansed of foreign matter; yet if the pieces in this state are plunged into a gilding or silvering bath, they become entirely black, and without any metallic lustre. If the pieces are put aside without rinsing, there rises on their surface a green froth and nitrous vapour, which indicate the decomposition of the acid with which they are contaminated. When the vapours have disappeared, the pieces, even after washing, remain of a dull black, on account of the formation of a basic copper salt which is not soluble in water. This last mode of operating, called blacking by aquafortis, is preferred by a few gilders, varnishers, and colour fixers, who find it economical to allow the production of nitrous vapours while the pieces are draining on top of the vessel which contains the acids. Any subsequent operation is to be prefaced by a rinsing in fresh water. When small objects, such as pins, caps, or eyelets, are to be dipped, they are put into a stoneware pot, with a small quantity of aquafortis, and then rapidly shaken and stirred. In this case the acid is entirely used up with the production of abundant vapours, and the objects remain blackened, and ready for a further cleansing. Care must be taken in the choice of aquafortis. Three kinds of nitric acid at 36° are to be found in the trade;—One is perfectly white, another

is straw yellow, and another which is of a more or less dark-red colour. The white acid, without nitrous gas, does not cleanse well, especially when freshly used. The red acid acts too powerfully and pits the copper. The straw-yellow acid is preferred to the others. Nitric acid at 40° is too energetic and costly; however, certain operators who have to cleanse large quantities of copper wares prefer it on account of the rapidity of the operation. The acid is spent when its action on copper goods becomes too slow, and when the objects removed from the bath are covered with a kind of bluish-white film. Such acid is preserved for the preceding operation, namely, dipping in old aquafortis; or for dipping in the whitening bath. Very good aquafortis may cleanse imperfectly when the temperature is too low or too high. This accounts for the difficulty of cleansing in frosty weather, or during the great heat of summer.

Aquafortis for Bright Lustre.—There is an excellent way of obtaining a bright lustre for any pieces, the surfaces of which have been dulled or slightly pitted by a defective cleansing, or by their passage through the acids for removing gold or silver. Place them for a few minutes in a bath composed of old aquafortis, nearly spent, 1 part; hydrochloric acid, 6 parts; water, 2 parts. The pieces, when removed from the bath, are entirely black, and must be thoroughly rinsed in water to remove the kind of black mud which covers them. They are then cleansed and dipped again. This bath will be found useful by electro-gilders. It is also convenient for removing the sand adhering to the castings of copper alloys. Large pieces may remain in the bath for 20 or 30 minutes, as this mixture acts very slowly on copper and its alloys.

Dipping in Compound Acids for a Bright Lustre.—These acids are of two kinds, according to the object in view. If the pieces are to have a bright lustre, they are stirred for 1 or 2 seconds in a liquid, prepared the day before, and cold, made of nitric acid at 36°, 100 parts; sulphuric acid at 66°, 100 parts; common salt, 1 part. In preparing this bath, nitric acid is first put into the vessel, and then sulphuric acid, which is much denser, and would not mix readily if it were put in first. At the time of mixing, especially when the salt is added, considerable heat and a quantity of acid and injurious fumes are produced, so that it is prudent to operate in the open air, or under a good chimney-hood with a movable glass sash. As these acids must be employed cold, it is necessary to prepare them in advance. Copper articles, after this dipping, are lighter coloured and much brighter than after the passage through aquafortis. They may then be considered as completely cleansed, and must be immediately rinsed in plenty of clean water. The above acids are too energetic for small articles, such as pins or hooks, which are generally cleansed in stoneware colanders. As the number of small articles stop up the perforations, the acid cannot run out so quickly as desired, and begins to heat and give off fumes, and the pieces blacken before they can be rinsed. Therefore, for small pieces, add to the above mixture one-eighth of its volume of water. Place the articles in a stoneware pot; stir rapidly with a small quantity of bitters, as the last mixture is termed, and then the whole is plunged into a quantity of fresh water as soon as the acid has sufficiently acted. This method is not economical, as the acid is lost; but the dipping liquors do not become heated.

Whitening Bath consists of old aquafortis, sulphuric acid, common salt, and uncalcined soot. Pour into a large stoneware vessel a certain quantity of old aquafortis from previous dippings, and then add twice the volume of sulphuric acid at 66°. The mixture is allowed to cool off until the next day. The nitrate of copper of the old aquafortis becomes converted into sulphate of copper, which, by cooling, crystallizes against the sides of the vessel. Decant the liquid portion into another vessel, and then add 2 or 3 per cent. of common salt, and as much of calcined soot. This mixture is much less energetic than the compound acids for a bright lustre, and often re-

places them advantageously. The crystallized sulphate of copper is collected and sold. This bath is strengthened, when necessary, by the addition of stronger aquafortis and oil of vitriol. To replace the portion used up during the day, equal quantities of old aquafortis and oil of vitriol are added at the end of the day. The next morning the liquors are decanted, and the sulphate of copper is gathered. Soot and common salt in sufficient proportions are then added. In this manner a perpetual and cheap whitening bath is prepared.

Compound Acids for a Dead Lustre.—If it is desired to give the objects a dead lustre, they are, after dipping in aquafortis and rinsing, plunged into a bath, prepared previously, composed of nitric acid at 36°, 200 parts; sulphuric acid at 66°, 100 parts; common salt, 1 part; sulphate of zinc, 1 to 5 parts. Copper articles may remain from 5 to 20 minutes in the cold bath, and the dead lustre will be the more apparent, the longer the immersion has been. From this bath, after a long rinsing, the objects have an earthy appearance. This dulness is removed by a rapid passage of the pieces through the compound acids for a bright lustre, and by an immediate rinsing. If they remain too long in the latter acids, the dead lustre will disappear, and the operation for dead lustre will have to be repeated. If a bath for the bright lustre is not at hand, the objects, after rinsing, may be rapidly passed through the dead-lustre bath, which will remove the dulness of the lustre caused by too long immersion. After long use, the compound acids for a bright lustre may be employed in a certain measure for a dead-lustre bath. The mode of operation remains the same. For large embossings for furniture, or for some clocks, a hot bath for dead lustre is used, composed as follows;—Old aquafortis, about 4 to 5 parts; sulphuric acid, 1 part; sulphate of zinc, 8 to 10 per cent. The sulphate of zinc is gradually added when required, for increasing the deadness of the lustre. The lustre thus obtained appears dull and yellowish; after a thorough rinsing, a passage through the same bath for 1 or 2 seconds, and a last rinsing, it becomes clear enough.

Dipping in Nitrate of Binoxide of Mercury.—This operation consists in plunging the cleansed articles for 1 or 2 seconds into a solution of water, 2½ gallons; nitrate of binoxide of mercury, a third of an ounce; nitric acid or, preferably, sulphuric acid, two-thirds of an ounce. When nitrate of binoxide of mercury is poured into the water, a thick cloud is formed, of a yellowish-white colour, which subsequently disappears. Stir the mixture before using it. The proportion of mercury salt above-named must be modified, according to the size of the pieces, and the nature of the alloy. Thus less mercury will be used for light pieces of jewellery which need a very thin deposit. On the other hand, more mercury is required for heavy objects, such as table ornaments, which should receive a thick deposit of gold or silver. The latter must come from the mercurial solution with a perfectly white and bright appearance, looking like silver, whilst the colour of the light articles is scarcely changed. After a perfect cleansing, the pieces will, after passing through a strong mercurial solution, be perfectly white and bright. But there will be a cloudy appearance, or various shades of colour, if the cleansing has not been properly done. The amalgamating bath becomes spent by use; it may be revived by the addition of a few drops of nitrate of mercury; but it is better to prepare a fresh one. No intervals must be allowed between the various operations of cleansing. The dipping baths are ordinarily held in vessels of glass, stoneware, porcelain, or of any other material which resists the corrosion of acids. Common earthenware and that with a lead glaze must be carefully avoided. The dipping pots must be rather high, and be furnished with a cover, in order to prevent evaporation. Those with ground edges may be covered with a pane of glass. Wide open-mouthed earthen pans are very good for rinsing. A large hood, communicating with a chimney, and closed with a sliding glass sash, should contain the following apparatus for complete

cleansing operations; — A furnace and separate pans for first dipping, old aquafortis, aquafortis and soot, compound acids for dead lustre, compound acids for bright lustre, solution of nitrate of mercury, acids to dissolve gold from old pieces, acids to dissolve silver from old pieces; with two large pans for rinsing with a constant flow of water. If the draught of the chimney is not sufficient, a small fire may be kindled under the hood. A gas-burner is often sufficient. The pot of nitrate of mercury, with two rinsing pans, may be placed near the electroplating bath.

CLEANSING SILVER. — Mechanical agents will not, like acids, act simultaneously on every part of the object, and it is impossible to entirely prevent the action of the air, steam, gases, and acid fumes. Heat the object to a dull red heat upon a slow fire. If the silver is pure, it becomes covered with a thin bluish film; but if, as is nearly always the case, the silver is alloyed with a variable proportion of copper, the latter becomes oxidized, and covers the piece with a greyish-black coating. While the piece is still hot, plunge it into a boiling pickle of water and sulphuric acid, which dissolves the oxide. If the heat has been sufficiently protracted for oxidizing all the copper on the surface, the object, when removed from the pickle, is of a perfectly dead white. It is greyish if the heating has been too short, and the operation must be repeated as many times as are needed for a perfect lustre. Or the silver may be placed in sheet-iron boxes filled with a mixture of powdered borax, lime, and charcoal dust. The borax dissolves the oxide of copper as soon as formed. If the objects to be cleansed are hollow, it is necessary, before heating, to make a small hole which will allow of the escape of the air expanded by the fire. Without this precaution, the piece will burst open. When the piece is put into the pickle, the acid liquor enters through the hole, and takes the place of the air between the shells, and is difficult to remove. In order to prevent the spotting of the piece by this liquor, it is dipped for a few minutes into a very dilute solution of ammonia or of soda crystals, which prevents the action of the acid upon the silver. Then place the article between layers of dry and warm fir wood saw-dust, which will absorb the saline solution. Nitric, instead of sulphuric, acid may be used for the pickle bath. In this case, the water must be distilled, and the acid free from chlorine or hydrochloric acid, otherwise the silverware will be covered with a bluish-white film of chloride of silver This method will not suit articles in which iron or zinc may be present. In such cases, employ alkalies, and polish afterwards with very fine sand or pumice-dust, with the aid of a stiff and short brush, or with a scratch-brush alone. Perfectly cleansed silver may directly receive a metallic deposit which will have the same dead lustre as the object itself, but it is customary, before introducing the articles into the electroplating bath, to scratch-brush them.

SCRATCH-BRUSHING. — Scratch-brushing is to remove the dead lustre on an object by the frequently-repeated friction of the points of many stiff and straight metallic wires, called a scratch-brush or wire-brush. Its shape varies with the articles to be operated upon. A hand scratch-brush is made of numerous wires, stiff and straight, taken from a bundle or coil of large diameter, so that the wires have little tendency to curve. For delicate objects, scratch-brushes are made of spun glass, the fibres of which are very thin and elastic. For making a good hand scratch-brush, choose a bundle or coil of brass wire of the proper thickness, and wrap a good string tightly round it for about two-thirds of the intended length of the instrument, usually about 8 inches. Then, with a cold chisel, cut the bundle of wire close to the string at one end, and at 2 inches from the other end of the string wrapping. Dip the end closed by the string into a neutral solution of chloride of zinc, and plunge into melted tin, which solders all the wires, and prevents their separation and injury to the hand of the operator. The tool is then fixed to a thin wooden handle which projects above the soldered end. Very small scratch-brushes are necessary for

reaching small holes and corners. An old scratch-brush, the wires of which have been bent in every direction, and fixed to a long handle, is useful for rubbing the insides of certain pieces, such as Etruscan vases. Scratch-brushing is seldom done dry; the tool and pieces must be constantly wetted with a stream of water, which carries away the impurities. Good metallic deposits are only polished by the friction of the scratch-brush; bad ones scale off from the defective adhesion. A large tub, with a board placed across it, on which to rest the pieces, may be used; and various solutions are employed to assist the brushing, such as water and vinegar, or sour wine, or solutions of cream of tartar or alum, when it is desired to brighten a gold deposit which is too dark; but generally a decoction of liquorice-root, horse-chestnut, marsh mallow, or bark of Panama wood, all of which allow of a gentle rubbing with the scratch-brush, with the production of an abundant scum. Every 5 or 6 days the old liquid is carefully decanted, so as not to carry away the deposits at the bottom, which always contain some of the precious metals, which are collected to be afterwards treated. For small objects and articles of jewellery, hold the scratch-brush as a writing pen, and the motion is imparted by the wrist only, the forearm resting on the edge of the tub. For larger articles of bronze, hold the fingers extended close to the fore part of the scratch-brush, so as to maintain the wires, and, with raised elbow, strike the piece repeatedly with a sliding motion at the same time. When a hollow is met which cannot be rubbed lengthways, a twisting motion is given to the tool. Circular wire-brushes, fixed on the spindle of a lathe, and the wires of which move all in the same direction, have been constructed for certain pieces of silversmith work, such as forks and spoons.

Lathe for Scratch-brush.—An ordinary lathe is used for scratch-brushing, upon the spindle of which is fixed a circular brush of brass wires. A wooden frame covers the wire brush; it is open in front; the top supports a small reservoir from which a slender jet of water runs upon the brush. A board receives the projected water, and lets it fall into a zinc pan resting on the bottom of the box.

Scratch-brushes.—The brass wire used for the manufacture of hand or circular scratch-brushes is of various strengths. Thick wires are employed for bronzes, and thinner wires for lighter articles. The wires must be preserved stiff and straight. When a hand scratch-brush becomes too short, cut the twisted ends with a cold chisel, and a new portion of wire is uncovered by removing part of the string wrapping. To remove the twisted wire ends, rest the scratch-brush upon a lead block, and cut them with a sharp cold chisel, with one stroke of a hammer if possible. When they begin to curl, they are now and then beaten with a mallet of boxwood, upon a small block kept between the knees, so as not to produce a dead stroke. Scratch-brushes if kept too long in water become hard; when greasy, they are cleansed in caustic potash; oxide is removed by the compound acids. This last operation, and even dipping in aquafortis, are sometimes resorted to for diminishing the size of the wires, and making them smoother. The circular brush is occasionally resorted to for diminishing the size of the wires, and making them smoother. The circular brush is occasionally reversed, in order to change the direction of the wires.

Bright Lustre for small Articles.—Very small articles, which cannot be scratch-brushed, receive a bright lustre by mutual friction. The operation is generally performed with the hands. The articles to be brightened are introduced, together with boxwood saw-dust, bran, or sand, into a bag; the ends of the bag being gathered into the hands with the thumbs inwards, the bag is shaken to and fro. As this operation becomes very fatiguing, mechanical means may be employed to effect the shaking.

CLEANSING ZINC.—Zinc is cleansed by being passed through a boiling solution of caustic lye, without remaining too long in it, because it may be corroded, and even dissolved; after rinsing, it is plunged for a few minutes into water contain-

ing from one-tenth to one-twentieth of sulphuric acid, then rinsed in plenty of warm water, and, when necessary, brushed with a stiff brush and pumice-stone dust, or scratch-brushed. This last operation is especially useful when parts have been united with tin solder, which becomes black and dull by the alkaline and acid baths. Another method is to dip the articles rapidly into a cold mixture of sulphuric acid, 100 parts; nitric acid, 100; common salt, 1 per cent.; and quickly rinse in cold water perfectly free from copper salt, which will blacken the zinc. If, instead of quickly cleansing the zinc, it is allowed to remain a little longer in the mixture, it acquires a dead lustre which may be utilized for producing contrasts between the various parts of the same ornament. The dead lustre will become a bright one, if the object is quickly plunged in several times, and rinsed as often, in the same compound acids. It often happens that the lines of tin or lead solder are black after being dipped into the acid bath; it is then sufficient to scratch-brush before placing the object in the electroplating solution. Zinc may be slightly amalgamated with the solution of nitrate of binoxide of mercury; this increases the adherence of the electro deposits. It is often necessary, from some defect in cleansing, or in electroplating, which impairs the adherence of the deposits, to do the work over again. In such a case, remove the copper entirely by plunging the object into aquafortis and soot, until it appears black. Another dipping into the compound acids will render it perfectly clean and white, and ready to receive a new deposit.

Cleansing Lead and Tin.—Tin, lead, and the alloys of these metals, are much more difficult to cleanse than zinc. A rapid scouring with potash lye, and a rubbing with a hard substance are the only means of effecting this. The objects are sometimes plunged into diluted hydrochloric acid; but the first operation is nearly always necessary. Notwithstanding the greatest care, the direct deposit of the precious metals is difficult, and does not adhere well. The results are much better if a coat of pure copper or brass is interposed between the low metal, and the gold or silver.

Cleansing Cast Iron.—Cast iron is cleansed by being immersed for 2 or 3 hours in water containing one-hundredth part of sulphuric acid; the metal is afterwards rinsed in cold water, and scoured with sharp sand and a fibre brush, or a coarse rag; then put again in the acid pickle, rinsed, and plunged into the electro bath. If more than 1 per cent. of sulphuric acid is added to the water, the length of the immersion must be shortened, otherwise the cast iron will be deeply corroded, and the carbon of the metal, which is insoluble in the pickle, will with great difficulty be removed by the friction of the sand. Cast iron does not gild or silver well, by a direct deposit of the precious metals. Copper or brass deposits are better, although far from perfect; but if cast iron is tinned, the coat is adherent, and will afterwards receive copper, brass, gold, or silver, if desired. If it is desired to keep cast iron already cleansed for some time before electroplating it, it is necessary to preserve it in a liquor rendered alkaline by caustic lime, potash, or soda, or their carbonates; but caustic lime-water is the cheapest and most easy method, and cast iron which has remained in it for a few hours will not rust after a long exposure to a damp atmosphere.

Cleansing Wrought Iron. — The cleansing of wrought iron is effected in the same manner as cast iron, but will bear a stronger pickle and a longer immersion. We refer in this place to ordinary wrought iron covered with a film of black magnetic scale or of red rust. Whitened, filed, or polished iron must be treated like steel.

Cleansing Steel.—Polished articles of steel, or iron, must be first cleansed in a boiling solution of caustic lye, and rubbed with pumice-stone dust, which scratches the polish slightly, and thus produces a better hold for the metals afterwards to be deposited. They are then rapidly passed through a bath composed of water, 1 quart; hydrochloric acid, 12 oz.; or sulphuric acid, 4 oz.; rinsed in cold water, and plunged into

the electroplating solution. Carefully avoid substituting nitric acid for the hydrochloric or sulphuric acid, of the above acid bath. Iron and steel may be well gilt, without an intermediary coat, in hot gilding baths. Silvering directly upon steel or iron is always imperfect and without adherence; it is therefore customary to interpose a coat of copper or brass, which renders the further operation of silver plating easy.

Galvanic Batteries.—There are two kinds of batteries used for electro-deposition; those which act under the action of physical agents; but these, on account of their feeble intensity, are rarely used. Others act under the influence of chemical reactions, of decompositions and recompositions, or of greater or less affinities. The varieties of these instruments are, at the present time, very numerous. But the best battery is that which, under the smallest volume, is the most energetic, constant, regular, and economical.

Daniell's Battery.—This battery develops a constant and lasting current, but is wanting in intensity. It is especially adapted to slow deposits, which must be thick and of uniform texture. A great advantage of this battery is, that it will work without acids, and therefore without the production of gases or smell, and can be used in a private apartment without inconvenience. The vase for the battery is a flat vessel of pure copper, which is half filled with a saturated solution of sulphate of copper, into which is placed a bag of canvas or a cell of porous procelain or earthenware, which causes the solution of sulphate of copper to rise to about 1 in. from the top of the copper vessel. The bag or cell is filled with a saturated solution of common salt, in which a well-cleansed zinc plate is placed. It is necessary that the levels of the two solutions should be nearly the same. If there is any difference, the solution of chloride of sodium should be slightly above the other, because if the solution of sulphate of copper passes into the porous cell, the zinc is immediately corroded, and blackened, and the battery may cease to work. When one of Daniell's elements only is used, which seldom happens, on account of the feeble intensity of the current, the conducting wire which supports the article to be galvanized is connected with the zinc plate by a binding screw of brass, and the other wire supporting the anode is connected with the copper of the exterior vase. The solution of sulphate of copper must be kept constantly saturated with crystals of this salt, enclosed in a bag of linen or hair cloth. A similar process may be employed to keep the solution of common salt in a state of saturation. A battery thus arranged may be kept in operation for three weeks, or a month. When this battery is working, the copper of the decomposed sulphate is deposited upon the copper of the vessel, which thus increases in weight and in value. The zinc is slowly dissolved in the solution of common salt, and forms a double chloride of sodium and zinc. When a number of the elements of a Daniell's battery are to be joined together, the zinc of the first element is connected with the copper of the second by means of a well-cleansed metallic ribbon, then the zinc of the second with the copper of the third, and so on, until the whole apparatus presents at one end a copper vase, and at the other a zinc plate, unconnected. A metallic wire connects the anode with the copper end, and a similar wire is bound to the zinc end, and supports the object to be electroplated. Another battery used by the electro-gilders of watch parts and by telegraphers, is composed of a cylindrical vase of stoneware, glass, or porcelain; a cylinder of zinc to which is soldered a ribbon of pure copper; a porous clay cell, and a glass balloon with a short neck, and filled with crystals of sulphate of copper. It is closed with a cork perforated with two holes, or having two notches cut along its sides. The rolled zinc plate is put into the stoneware pot, and the porous cell inside the zinc. The copper ribbon of the zinc of the first element dips on to the bottom of the cell of the next element, in such a manner that, when several elements are connected together,

there is at one end the ribbon of a zinc plate, and at the other end a copper ribbon put into the cell. Then the porous cell and the stoneware pot are filled to the same level with water. The balloon containing the crystallized sulphate of copper receives as much water as it can hold, and the notched cork being put in place, the balloon is quickly inverted with its neck in the water of the porous cell. The battery is ready to work 24 hours after. The ribbon of the zinc end is connected with the objects to be electroplated, and that of the other cell end, with the soluble anode. The sulphate of copper contained in the balloon is dissolved in the water around it, and as this solution is denser than water it falls into the porous cells through one of the notches of the cork, while an equal quantity of purer and lighter water ascends through the other notch, and so on, producing a circuit of denser liquor falling by one notch, and of lighter liquor rising by the other. The solution of sulphate of copper is decomposed in the porous cell; the sulphuric acid passes through the cell by outward pressure and acts upon the zinc, and at the same time the copper becomes deposited upon the copper ribbon connected with the zinc of the former element. In order that this battery may work regularly for 6 or 7 months, it is sufficient to replace the evaporated water. The balloon ought to contain at least 2 lbs. of sulphate of copper, and the zinc to be about 7 in. in height, and from 4 to 4½ in. in diameter. The zinc may be amalgamated, in which case the action is a little slow at the start, but more regular afterwards. The copper ribbon receives all the metal of the decomposed sulphate, and it sometimes happens that part of the copper becomes deposited upon the porous cell, which must then be cleaned in aquafortis. When all the sulphate of copper is used up, the balloons are filled with a fresh quantity of crystals and new copper ribbons inserted to take the place of those rendered too voluminous. If it be desired to start the battery with a balloon immediately, add a small quantity of sulphuric acid, or of common salt, to the water in which the zinc is placed.

Bunsen's Battery.—Each element is composed of a glass vessel which is half filled with nitric acid at 36° or 40° Baumé, and which receives a hollow cylinder of pulverized coke, moulded and cemented at a high temperature, by sugar, gum, or tar. At the upper part of this cylinder, where it does not dip into the acid, a copper collar is fixed, which may be tightened at will by means of a screw. A copper band or ribbon is fixed to the collar, and may be connected with the zinc of another element. A porous porcelain cell is placed inside the coke cylinder, and contains a diluted solution of sulphuric acid, 1 part acid and 9 parts water, into which is put a bar or cylinder of zinc strongly amalgamated, or covered with mercury. When a battery of several elements is to be formed, the coke of the first element is connected with the zinc of the second, and so on, and the apparatus is completed, at one end, by coke communicating with the anode, and at the other, by a zinc connected with the cathode, or object to be electroplated. In this apparatus the surface of the carbon is much greater than that of the zinc; this is a wrong disposition, since, generally, the intensity of the current is in direct ratio with the surface of the zinc corroded, provided that this surface be opposite and parallel to that of the carbon.

Bunsen's Battery modified by Archereau.—This battery is preferred by gold and silver electroplaters. Each element is composed of an exterior vessel or pot, most generally of stoneware; a cylinder of zinc, covered with mercury, provided with a binding screw, or with a copper band, whether for a single element, or for the end of a combination of elements in a battery, or to connect the zinc with the carbon of another element. A porous cell of earthenware pipe or porcelain. A cylinder of graphite, made from the residue found in old gas retorts. The graphite is bound by a copper band fixed to it by means of a wire of the same metal, all the binding being afterwards covered with a

thick varnish to protect it from the acid fumes of the battery; notwithstanding the varnish, the acid may rise by capillary attraction and corrode the copper band between the carbon and the wire; therefore binding screws of various shapes and sizes should be used to connect the carbon or zinc by means of ribbons, or wires. Use conducting wires of pure copper, covered with cotton, silk, india-rubber or gutta-percha, and presenting the metal at their extremities in order to effect the connections.

Charge of the Battery.—Taking as a standard an element 10 in. in height, and 6 in. in diameter, half fill the stoneware pot with water; add 7 oz. of sulphuric acid at 66°; and 1 oz. of amalgamating salt, or the zinc may be amalgamated with metallic mercury, after it has been cleansed in diluted sulphuric acid, by being dipped into mercury, or rubbed over with this metal by means of a scratch-brush of brass wire. Put the zinc cylinder into the stoneware pot; then introduce the cylinder of carbon into the porous cell; fill the empty space between the carbon and the sides of the cell with nitric acid at from 36° to 40° Baumé; place the porous cell thus filled into the centre of the zinc cylinder. The surfaces of the two liquids should be level.

Reunion of Several Elements.—When several elements are to be connected, they are placed near each other, without touching, and the first carbon or graphite is left free for the attachment of the anode. The ribbon or band of the first zinc is pinched between the jaws of the brass binding screw, and the carbon of the second element, and so forth, until the last zinc is ready to be connected with the object to be electroplated.

Bringing Batteries into Action.—Batteries will furnish electricity when the circuit is closed, that is to say, when the conducting wires starting, one from the carbon, and the other from the zinc, are put into communication, whether by direct contact or through the medium of a conducting liquid. It sometimes happens that batteries, which appear to be in good order, do not work. This is generally due to some foreign substance preventing the conductibility at the points of contact, or to the copper band of one zinc resting upon another zinc. Before using a battery, try if the current escapes well from both extremities. For this purpose present the point of the negative wire to the carbon of the other end, and a spark should immediately ensue. The same experiment being made with the positive wire, against the last zinc, another spark should be produced; or it is still more easy to have the two ends of the wires made to rest at a short distance from each other upon a piece of carbon, or upon a file, and then rubbing with one wire while the other remains in contact. Numerous sparks will immediately appear. When one element of a battery is wrongly put up, discover the defect by successively presenting the end of one of the wires to the carbon of each element, and that which does not produce any spark belongs to the defective element. Too much porosity in the cells is another cause of stoppage in the current, because the solution of zinc which penetrates deposits upon the carbon a whitish coat preventing further action. Change the cell and scrape off the coat entirely from the carbon. This generally takes place when the battery has been working several days without the addition of fresh liquor, or when there is too much acid. The battery will also cease working from too great an accumulation of sulphate of zinc, which, not having sufficient water to remain in solution, crystallizes upon the zinc, and prevents any further action. Remove the acid solution, substitute a fresh one, and clean the zinc. Laminated zinc is preferable to that cast in a mould, because the latter is not so homogeneous, and is more rapidly corroded, and even perforated.

Keeping Batteries in Order.—Every 24 hours, or oftener, the losses of batteries must be made good by adding, without taking the elements apart, about two teaspoonfuls of amalgamating salt, and as much of sulphuric acid, to the liquor of the zinc plates, and stirring

with a glass rod. Nitric acid, to replace that evaporated, is put into the porous cell. This manner of operating may be sufficient for 5 or 6 days; but after this lapse of time, all the old liquors must be removed, and fresh ones added. Although amalgamated zinc is scarcely corroded, even in a very acid solution, when the two poles are not in connection by direct contact, or through a conducting liquid, it is preferable to take the batteries apart every evening, in the following manner;—All the binding screws are let loose, and cleaned; the cylinders of carbon are removed, and, without washing, deposited in a vessel especially for their use; the porous cells are removed, and their acid poured into a special vessel. The cells are not washed; the zincs are removed from the acid liquor, and placed in an inclined position upon the edges of the stoneware pots; the batteries are made ready to work by a converse manipulation.

Important Observations on Batteries.—Batteries must be kept in a place where the temperature does not greatly vary. A frost arrests their action, and great heat increases it too much. A good place for them is a box, and they are put at such a height that they may easily be manipulated. This box should have means of ventilation, in such a way that the air coming in at the lower part, will escape at the top through a flue and carry away with it the acid fumes constantly disengaged. It is best to keep the batteries in a room different from that where the baths and the metals are to be operated upon, as these are easily injured by acid vapours. The galvanic current may be conducted into the workroom by wires passing through holes in the wall, and covered with gutta-percha.

Grove's Battery.—This battery is like the preceding one, except that it has a platinum foil which plunges into the nitric acid, and replaces the prism of carbon. This foil is supported by a small brass stand, fixed itself to a round band resting upon a rim on top of the exterior vase. A binding screw is soldered to the stand when connection is to be made with the copper ribbon of the preceding zinc. The several elements of batteries are united together in the manner already mentioned, the zinc to the platinum of the next element, and so on. The disadvantage of this battery is its great cost, due to the platinum employed; it has been proposed to substitute aluminium, but still the battery is an expensive one.

Grenet's Battery.—A solution of 100 parts of water, 10 of bichromate of potash, and 10 of sulphuric acid in the porous cell, replaces the nitric acid employed by Grove and Bunsen. This battery does not emit acid fumes, but the carbon is rapidly incrustated with oxide of chromium, which arrests the galvanic current.

Marié-Davy Battery.—Slightly damp sulphate of mercury replaces the nitric acid in the porous cell. The working expenses of this battery are very high, and it is used only in the telegraphic service, where the Daniell battery with balloons is preferred.

Smee's Battery.—This battery is very simple in construction. It is composed of a thick wooden frame open at the top, with three internal parallel grooves which run the height of the two opposite sides. The middle groove receives a movable plate of silver, platinum, gold, or copper which has been strongly gilt, silvered, or platinized; its surfaces must be rough or with a dead lustre. Two plates of strongly amalgamated zinc are run down the other two grooves. The plates of zinc must be near to, but not in contact with, the central one, and are connected by a wire or metallic band. The positive wire starts from the middle plate, and the negative from the zinc, and the whole apparatus is immersed in a solution containing common salt or one-tenth of sulphuric acid. Several elements may be united together by connecting the zinc of the first with the middle plate of the second. Or the cell may be made of gutta-percha, with a plate of carbon to replace the plate of silver, or of platinized copper. The two other grooves receive two plates of amalgamated zinc with one of the upper corners cut away. A double binding screw, for the positive

wire, is fixed upon the plate of carbon where the two zinc corners have been cut off, and another large binding screw unites the two zinc plates, and carries the negative wire. Fill the cell with water saturated with common salt, or acidulated with one-tenth of sulphuric acid.

Watt's Battery.—In a stoneware jar holding about 4 galls. place a cylinder of thin sheet copper, dipping into water acidulated with 2 lbs. of sulphuric acid and 1 oz. of nitric acid. A solid zinc cylinder is put into the porous cell, which is filled with a concentrated solution of common salt, to which a few drops of hydrochloric acid have been added.

Various Kinds of Metallic Deposits.—An intense current, for brass and hard deposits will be obtained by joining alternately the zinc of one element to the copper or carbon of the next one. For silver plating a smooth and not too hard deposit is desired, the current should be feeble in intensity, but considerable in quantity, and may be obtained by connecting together all of the zincs on the one side, and all of the coppers or carbons on the other.

Porous Cells.—The porous cells are absolutely necessary in batteries working with two exciting solutions, like the Bunsen battery. But the trouble arising from the clogging of the pores of the cell, and from the difficulty of preventing the diffusion between the two liquids of the porous cell and of the jar, the specific gravity of which is constantly varying, makes it desirable that the cell should be dispensed with in batteries worked with but one exciting fluid.

Callaud Battery.—The Callaud battery is a modification of that of Daniell, doing away with the porous cell. A jar is filled with water acidulated with sulphuric acid, only for starting the solution of the zinc, as the sulphuric acid will be furnished afterwards by the sulphate of copper. The zinc and copper plates are both placed horizontally in the jar; the zinc in the upper part, and the copper lying on the bottom. To start this battery, throw into the jar a few crystals of sulphate of copper. These go to the bottom, dissolve, and form a saturated solution around the negative plate of copper. The electrode or conducting wire from the copper plate may be made to pass through a glass tube reaching down to the bottom of the jar, and large enough to contain a supply of crystals of sulphate of copper necessary to keep a saturated solution in the lower part of the cell. This avoids disturbing the upper part of the liquid in which the zinc dips, and its mixture with the solution of sulphate of copper. The deposits from the zinc and other impurities are prevented from falling upon the copper plate, and thus interfering with the current, by covering the copper plate with a layer of clean quartz sand, which serves also as an obstacle to the effusion upward of the sulphate of copper, because the interstices between the grains act as a series of narrow tubes, but the force of the current diminishes by reason of the increased resistance.

COPPER DEPOSITS. — *By Dipping.* — Copper deposits are obtained either by simple dipping or galvanic methods. Copper deposits by dipping are seldom practised except upon iron, and are generally wanting in lasting qualities, since, from the thinness of the deposit, the iron is not protected against atmospheric influences. If the iron is steeped in a solution of sulphate of copper, 3½ oz.; sulphuric acid, 3½ oz.; water, 1 to 2 galls., for a short time, it becomes covered with a coating of pure copper, having a certain adhesion; but should it remain there for a few minutes, the deposit of copper is thicker and muddy, and does not stand any rubbing. In this case, compress it by means of rollers or a draw plate, in order to impart a certain cohesion to the particles of copper. Small articles, such as hooks, pins, or nails, are coppered by jerking them about for a certain time in sand, bran, or saw-dust impregnated with the above solution, diluted with three or four times its volume of water.

By Battery.—Electro-deposits of copper are obtained by decomposing a double

salt of copper with another base, such as the double cyanide of potassium and copper. This process is equally well adapted to all metals, and the deposits are fine, lasting, and their thickness is entirely regulated by the will of the operator. Dissolve about 16 oz. of sulphate of copper in 2 galls. of water, and add a solution of carbonate of soda until no more precipitate is formed; collect the green precipitate, carbonate of copper, thus obtained upon a cloth filter, and wash it several times with water; then stir the washed carbonate of copper in water, to which cyanide of potassium is added until the carbonate is entirely dissolved, and the solution is colourless. It is well to add a small excess of cyanide, which will increase the conducting power of the liquor. This bath may be employed hot or cold, and requires an intense electric current for its decomposition. A copper plate or foil forms the anode, and as it slowly dissolves, nearly makes up for the loss of copper in the bath which has deposited on the negative pole. This anode must be removed when the bath does not work, because it will be dissolved even without an electric current, and the bath having been overcharged with copper, which is indicated by a blue or green colour, will require a fresh addition of cyanide to be in good order. This bath is neither economical nor very reliable. The following formula is preferable;—Water, 2 galls.; acetate of copper, crystallized; carbonate of soda, crystals; bisulphite of soda; cyanide of potassium, pure, per cent., 7 oz. of each. For this bath the acetate of copper is put first into the vessel, and moistened with sufficient water to make a homogeneous paste. This salt, like flour, is wetted with difficulty, and will float on the surface of too great a body of water. The carbonate of soda and some water are added to this paste, and, after stirring, a light green precipitate is formed. Three pints more water are then added with the bisulphite of soda, and the mixture becomes of a dirty yellow colour. Lastly, add the remainder of the water and the cyanide of potassium. The electro-copper bath must be colourless. If, after the complete solution of the cyanide, the liquor is not entirely colourless, add more cyanide. If a perfectly limpid bath is desired, pass it through filtering paper, or decant it after settling. This bath requires an electric current of mediate intensity for its decomposition. The copper anode should have a surface nearly equal to that of the immersed objects. Large pieces are generally kept hanging and motionless in the bath, whilst small articles are moved as much as possible, which is always to be preferred, especially with warm baths. If it were always possible to obtain a pure cyanide of potassium, this formula would be satisfactory in every case. But it is very difficult to find a perfectly satisfactory cyanide of potassium; the following formulæ require a cyanide containing from 70 to 75 per cent. of the real article.

Cold Bath for Iron and Steel.—Bisulphate of soda and cyanide of potassium, 18 oz. of each; carbonate of soda, 36 oz.; acetate of copper, 17 oz.; aqua ammonia, 12½ oz.; water, 5½ gallons.

Warm Bath.—Bisulphite of soda, 7 oz.; cyanide of potassium, 25 oz.; carbonate of soda and acetate of copper, 18 oz. of each; aqua ammonia, 10 oz.; water, 5½ gallons.

Hot or Cold Bath for Tin, Cast Iron, or Large Pieces of Zinc.—Bisulphite of soda, 10 oz.; cyanide of potassium, 18 oz.; acetate of copper, 12½ oz.; aqua ammonia, 7 oz.; water, 5½ gallons. For small articles of zinc which are coppered in a perforated ladle, and in nearly boiling baths;—Cyanide of potassium, 25 oz.; bisulphite of soda, 3½ oz.; acetate of copper, 16 oz.; aqua ammonia, 5⅓ oz.; water, 4 to 5½ gallons. To prepare these different baths, dissolve all the salts in about 4 gallons of rain or distilled water, except the acetate of copper and the ammonia, which are dissolved apart in the remaining gallon. These two solutions are mixed, and that of copper and ammonia, which was of a magnificent blue, must become entirely colourless. When the liquors are not colourless there is a de-

ficiency of cyanide of potassium, which must be added until entire decolourization takes place. The bath is ready to work when subjected to the action of the electric current. The cold baths are put into well-joined tanks of oak or fir wood, lined inside with gutta-percha. The vertical sides are also covered with sheets of copper, which act as the soluble anode, and reach to just below the top edge of the tank. This anode is connected by the clean extremities of a conducting wire to the last copper or carbon, —that is to say, to the positive pole. Fix a stout brass wire upon the top of the tank, without any point of contact with the soluble anode, and connect by a second wire with the last zinc or negative pole of the same battery. The objects to be coppered are suspended in the bath by copper wires, supported themselves upon a stout, clean, brass rod, the two extremities of which rest upon the brass conducting wire fixed upon the tank. Several of such rods are placed parallel to each other, and great care must be taken to prevent any contact with the anode, because the working of the bath would then be immediately stopped. When the thickness of the deposited copper is very small, the coat is sufficiently bright to be considered finished after drying. But if the operation is more protracted, the deposit has a more or less dead lustre on account of its thickness, and, if a bright lustre is desired, we must use the scratch-brush. The hot baths are put into stoneware vessels heated in a water or steam bath, or into an enamelled cast-iron kettle placed directly over a fire. The insides are also lined with an anode of copper connected with the positive pole of the battery, and the edges of the vessels are varnished, or support a wooden ring upon which rests a brass circle communicating with the negative pole. The objects to be electroplated hang from this circle. The hot process is much more rapid than the cold, and is especially adapted to those articles which are difficult to cleanse, because any remaining greasy substance is dissolved by the alkaline bath. Parcels of small articles, metallic pens, for instance, are not suspended in the bath; they should be connected with the negative wire in the hand of the operator, and stirred about in every direction in the bath. This agitation permits of the employment of an intense current, without danger to the beauty of the deposit. Small articles of zinc are placed in a stoneware perforated ladle, at the bottom of which is attached a zinc or copper wire, which is wound up around the handle, and is connected with the negative pole of the battery. It is sufficient that one of the small articles touches the wire for all of the others to be affected by the current, as they are in contact with each other. If the bottom of the vessel is metallic, the ladle is made to rest upon a porcelain or stoneware ring. During the operation the articles are often jerked in the ladle; this agitation changes the position and the points of contact of the objects. When the deposit is being made too slowly bring up the bath by the addition of equal weights of acetate of copper and cyanide of potassium.

To Copper Silver. — Large pieces of silverware may be coppered in these baths. Very small articles are simply threaded upon a zinc or iron wire, or placed in a perforated ladle with granules or cuttings of either of these metals. Place the whole for a few minutes in a diluted but very acid solution of sulphate of copper, the zinc or the iron is dissolved, and the copper is deposited upon the silver. When the article is intended to be gilded or silvered, it is immediately passed through the solution of nitrate of binoxide of mercury, rinsed in cold water, and placed in the electro-baths, without drying or scratch-brushing.

Brass Deposits.—All the manufactures of bronze composition made of zinc or cheap alloys, have a brass deposit placed on before the bronze lustre is given, as the bronzing operation is more easy and satisfactory upon brass deposits. The preliminary and finishing operations and the disposition of the baths are the same for brass as for copper deposits Heat is

employed for brass deposits by those who electroplate coils of iron or zinc wire with this alloy. The proper temperature varies from 130° to 140° F., and the coils of wire dip only one-half or two-thirds of their diameter into the bath. The bath is put into an oblong open iron boiler heated by fire, steam, or hot water. The inside is lined with brass sheets connected with the positive pole of a battery. A stout copper or brass rod, in the direction of the length of the boiler, rests upon the edges, and the contact of the two metals is prevented by pieces of india-rubber tubing. The rod is connected with the negative pole by a binding screw. Remove the binding wire from the coils, and loosen the wires, bending the ends together into a loop. Dip the wire in a pickle of diluted sulphuric acid, and hang it on a strong round peg held in the wall, so that the coil may be made to rotate easily. After a scrubbing with wet, sharp sand and a hard brush, give the coil a primary deposit of pure copper. It is then suspended to the horizontal rod over the brass bath, where only a part of the coil at a time dips into the solution and receives the deposit; the coil must be turned now and then one-half or one-fourth of its circumference: by dipping the coil entirely into the liquid, the operation is not so successful. The wires are washed, dried in sawdust, and then in a stove, and lastly passed through a draw-plate, to give them the fine polish of true brass wire. Copper and brass wires are also covered with brass electro-deposits, in order to give them various shades.

Solutions for Brass Baths.—The ordinary cyanide of potassium is often preferred to the pure article, on account of its lower price; but the real value and dissolving property of ordinary cyanide are very variable. The following is a general method by which a bath of brass may be prepared with any kind of cyanide;—1. Dissolve together, in 2 gallons of water, 8 oz. of sulphate of copper, and 8 to 10 oz. of sulphate of zinc. 2. 4 oz. of acetate of copper, with 4 to 5 oz. of fused protochloride of zinc; and add a solution of 30 oz. of carbonate of soda, which produces a precipitate of the carbonates of copper and zinc: allow this to settle; then decant the supernatant liquor, and replace it by fresh water two or three times, after as many settlings. Then pour on 2 gallons of water containing, in solution, 30 oz. of carbonate of soda, and 15 oz. of bisulphite of soda; while stirring with a glass or wooden rod, add ordinary cyanide of potassium until the liquor is perfectly clear, or until nothing but the greyish-black iron, found in the cyanide, or the brown-red oxide of iron in the sulphate of zinc, remains in suspension. An additional quantity of about an ounce of ordinary cyanide improves the conducting power of the liquor. With pure cyanide of potassium, or the ordinary cyanides with a constant and known composition, use the following mixtures. *Cold Brass Bath for all Metals;* Carbonate of copper, recently prepared, and carbonate of zinc, recently prepared, each 4 oz.; carbonate of soda, in crystals, bisulphite of soda, and cyanide of potassium, pure, each 8 oz.; and $\frac{1}{10}$ of an ounce of white arsenic; water, about 2 gallons. This bath is prepared as follows; Dissolve, in 3 pints of water, 5 oz. of sulphate of copper, and 5 oz. of crystallized sulphate of zinc, and add a solution of 14 oz. of carbonate of soda in a quart of water. A greenish precipitate of mixed carbonates of copper and zinc is formed, stir well, and allow to deposit for several hours. The supernatant liquid, holding the useless sulphate of soda, is thrown away, and replaced by nearly 2 gallons of water, in which are dissolved the bisulphite and carbonate; dissolve together in the remaining warm water the cyanide of potassium and the arsenious acid, and pour this liquor into the former one, which is rapidly decolourized, and forms the brass bath. Filter if necessary. Arsenious acid causes the deposit to be bright, but if in too great a proportion may give a white or steel-grey colour to the metal. This inconvenience is slight, as the yellow colour soon predominates. The arsenious acid may be replaced by soluble arsenites of potash, soda, or ammonia, but the proportions must be doubled. The baths

for cold electroplating are generally placed in wooden tanks lined inside with gutta-percha, which resists their action for a long time. The sides of the tank are also lined with one or more brass sheets joined together, connected with the last carbon or copper of the same battery, the intensity of which is regulated by the surface of the articles to be electroplated. The articles are suspended by copper or brass hooks to stout rods of the same metal, all connected with the last zinc of the battery.

Correcting the Brass Bath.—The losses of the solution are to be repaired by additions of copper and zinc salts, and arsenious acid, dissolved in cyanide of potassium. The operator will determine the needed substances from the rapidity of the deposit, its colour, and so on. If the deposit is too slow, try whether the bath will absorb the salts of copper and zinc, without the addition of cyanide. If the coat of brass has an earthy and ochreous appearance, and especially if the liquor is blue or green, add cyanide of potassium until perfect decolourization takes place. If the deposit is dull and unequal, add a small quantity of arsenious acid dissolved in cyanide. If the deposit is too red, add the salt of zinc, alone, or dissolved in cyanide. If the deposit is too white, or of a greenish-white colour, add the salt of copper alone, or dissolved in cyanide. When the bath after long use has become overloaded with salts, the specific gravity is too great for the easy passage of the electric current, the liquor must be diluted with water until it works satisfactorily. The specific gravity of a brass bath may vary from 5° to 12° Baumé. The pieces, before brass electroplating, must be perfectly cleansed in the same manner as zinc or iron; if the brass deposit is irregular, remove the objects from the bath, rinse, scratch-brush, and put again into the bath until the colour and the thickness of the deposit are satisfactory. Scratch-brush again, and, if necessary, rinse in hot water, dry in warm saw-dust of white wood, and put in the stove-room. The last three operations are indispensable for hollow-pieces.

Brass Bath for Steel, Wrought and Cast Iron, and Tin; using ordinary Cyanide of Potassium.—Dissolve together in 14 pints of pure or rain water;—Bisulphite of soda, 7 oz.; cyanide of potassium, No. 2, 17 oz.; carbonate of soda, 34 oz. To this solution add the following, made in 3½ pints of water;—Acetate of copper, 4½ oz.; neutral protochloride of zinc, 3½ oz. The two liquors become colourless when mixed. Ammonia must not be used for brass electroplating baths for iron, especially for solutions worked in the cold.

Brass Bath for Zinc.—Pure or rain water, 4½ gallons; bisulphite of soda, 24½ oz.; cyanide of potassium, No. 2, 35 oz. Add the following solution;—Water, 9 pints; acetate of copper and protochloride of zinc, each 12½ oz.; ammonia, 14 oz. The filtered bath is colourless, and gives, under the action of the battery, a brass deposit of a very fine shade, varying from red to green, by increasing the proportion of copper, or that of zinc. The anode is of brass.

Colour of Brass Deposit.—The difficulty in brass electroplating, especially with small baths, is in keeping the uniformity of the colour of the deposit, as the galvanic current, having simultaneously to decompose two salts each offering a different resistance, must, according to its intensity, vary the composition and the colour of the deposited alloy. It will be found that a feeble current principally decomposes the copper salt, and results in a red deposit; whilst too great intensity in the current decomposes the solution of zinc too rapidly, and the deposit is a white or bluish-white alloy. This is the case more especially with newly-prepared baths, and is an indication of irregularity in the conducting power of the bath, which, however, becomes more regular after being used for some time. The inconvenience of a red deposit may be remedied by increasing the number of the elements of the battery, or employing stronger acids, or decreasing the number and the surfaces of the objects to be plated; the other inconvenience of white deposits will disappear by diminishing the number of elements, or

by increasing the surfaces to be covered. The deposit may also be modified by substituting for the brass anode, either a sheet of pure copper, or one of zinc, or by simply hooking one of these sheets to the brass anode. A bath of pure copper will be transformed into one of brass by the use of a zinc anode; and an electro-bath of brass will become one of copper by the aid of a copper anode.

Arrangement of the Brass Bath.—In the disposition of the baths for brass plating it is always necessary to have all the articles suspended at about equal distances from the anodes; the bath may be subdivided by several anodes forming partitions, so that each loaded rod is between two anodes, or smaller separate baths employed. The anodes should be removed when the bath is not at work. In order that the brass electroplating of zinc and copper may be lasting, the deposit must not be too thin, and must be scratch-brushed, rinsed in water rendered slightly alkaline by quicklime, and thoroughly dried in a stove. But generally the articles are brass electroplated by remaining in the bath for from 10 to 25 minutes. Cast and wrought iron, lead and its alloys, require brass solutions richer in the metals than when depositing brass upon zinc or its alloys. The battery power should also be greater.

Brass Plating by simple Dipping.—A colour resembling brass is given to small articles of iron or steel by a long stirring in a suspended tub, containing water, 1 quart; sulphate of copper and protochloride of tin crystallized, about $\frac{1}{7}$ of an ounce each. The shades are modified by varying the proportions of the two salts.

Brassing Lead and Pewter.—Lead and pewter should be cleansed in a solution of about 4 oz. of nitric acid to the gallon of water, in which they remain for half an hour. Pewter is more easily coated with brass than lead, but the same bath may be used for either. They are then rinsed, scoured with sand, and rinsed again. A good battery power and a large surface of anode are necessary, especially at the beginning of the deposit. The proper temperature of the bath for brassing lead, pewter, and tin is about 90° F. Stirring articles in a brass bath has a tendency to cause the deposition of copper alone.

TINNING. — *Tinning Bath,* by Exchange, for Iron.* — This process is of little importance as a protection for iron as the layer of tin is a mere film, but it may be useful when thicker coats of tin are to be applied by other processes. For the bath, dissolve with the aid of heat, in an enamelled cast-iron kettle, ammoniacal alum, 11 oz., and fused protochloride of tin, $\frac{1}{2}$ oz., in $4\frac{1}{2}$ gallons of soft water. The pieces of iron, previously cleansed and rinsed in cold water, are steeped in the solution as soon as it boils. They are immediately covered with a film of tin of a fine white dead lustre, which may be rendered bright by friction. The bath is maintained at the proper strength by small additions of fused protochloride of tin. This bath is convenient for a preliminary tinning of zinc; when the ammoniacal alum may be replaced by any other kind of alum, or by sulphate of alumina; but for wrought and cast iron and steel this substitution cannot be made.

Electro-Tinning.—The bath is composed of rain or distilled water, 110 gallons; pyrophosphate of soda or potash, 11 lbs.; crystallized protochloride of tin, 21 oz.; or 18 oz. of the same salt fused, in order to have it free from an excess of acid; put the water into a tank entirely lined with anodes of tin sheets, united together and connected with the positive pole, carbon or copper, of the battery. Then introduce the pyrophosphate of soda or potash, and stir it in; when dissolved, the protochloride of tin is put into a sieve of copper half immersed in the solution. A milky-white precipitate is produced, which disappears after continued agitation. When the liquid has become clear and colourless, or only slightly yellow, the bath is ready; then place upon transverse metallic rods, connected with the negative pole, the previously cleansed objects which are to be tinned. The anodes are

not sufficient to keep the bath saturated; when the deposit is too slow add small portions of equal weights of tin, salt, and pyrophosphate; put in by the aid of the sieve, as if fragments of protochloride of tin fall to the bottom of the bath they become covered with a crust, which prevents their solution. The tinning thus obtained upon any kind of metal is quite resisting, and has a white and dead lustre resembling that of silver. A bright lustre may be obtained with the scratch-brush or the burnishing tool. As the reduction of these baths requires an intense current, and the working of the batteries is expensive, the next process is preferable.

Tinning by Double Affinity.—The bath is composed of—1. Distilled water, 66 gallons; cream tartar, 6½ lbs.; protochloride of tin, 10½ oz. The powdered cream of tartar is dissolved in 44 gallons of warm water, and the tin salt in 22 gallons of cold water. The two solutions when mixed become clear, and the resulting bath has an acid reaction. Or, 2, distilled water, 66 gallons; pyrophosphate of potash or soda, 13 lbs.; protochloride of tin, crystallized acid, 21 oz.; or the same fused, neutral, 14 oz. The whole is dissolved at the same time on a metal sieve, and, after stirring, the bath is clear. Either of these solutions is kept in a barrel with the top off. This barrel has at its lower part two tubes placed one above the other, connected with a small boiler built below the level of the bottom of the tank. The tube, starting from the bottom of the tank, reaches nearly to the bottom of the boiler; the other tube, which is placed about three inches from the bottom of the tank, is connected to the top of the boiler; a bent safety tube, connected only to the boiler, prevents any explosion, should there be an obstruction in the other tubes. A small quantity of water or mercury in the bent arm of the safety tube will prevent the escape of steam, when it does not exceed the working pressure required. When the boiler and tank are filled with liquid, as soon as heat is applied the expanded and lighter liquid will rise through the upper pipe into the barrel, while the colder and denser one will flow into the boiler through the lower pipe. A continual circulation is thus obtained, which keeps up a constant agitation of the contents of the bath. Large pieces are cleansed and rinsed, and piled in the bath with a few fragments or spirals of zinc; the surface of the zinc should be about the thirtieth of that of the tinned articles. For small objects, such as pins or hooks, dispose them in layers about an inch thick upon perforated plates of zinc, which allow of the circulation of the liquid, and have their edges turned up so as to prevent the objects from falling off. These plates should be removed from the bath in the inverse order in which they have been put in. These zinc plates must be scraped and cleaned, so as to present fresh surfaces of zinc instead of the white crust, which prevents its contact with the articles to be tinned. The time for the operation varies from 1 to 3 hours. Then remove all the objects, and add to the bath 9 oz. of pyrophosphate, and as much of fused protochloride of tin. Whilst the solution is going on, scratch-brush the large articles, and stir the small ones about with an iron fork, to change the points of contact. The objects are then again steeped in the bath for at least 2 hours. The large pieces are scratch-brushed again, and the small ones rendered bright by mutual friction. Then dry the whole in dry and warm fir-wood saw-dust. Cast-iron cooking vessels thus tinned have a bright appearance, and have the advantage of never communicating any taste, smell, or colour to the food cooked in them, even when the tinning, after long use, has completely disappeared.

Colour of Tin Deposit.—If the tin deposit is grey and dull, although abundant, prepare the bath, once or twice, with the acid crystallized protochloride of tin. With a very white deposit, but blistered and without adherence or thickness, replace the acid salt by the fused one. In the latter case, also diminish the proportion of tin salt, and increase that of pyrophosphate; a great

deal of the success of the operation depends upon the quality of the pyrophosphate. When a tinning bath has been worked for a long time, decant the liquor to separate the pyrophosphate of zinc formed. And when, after several years, the solution is entirely used up from the alteration of the salts, it should be kept in preserving tubs, where the objects to be tinned are put after cleansing.

To Tin Zinc.—The proportions of the bath are as follows;—Distilled water, 66 gallons; pyrophosphate of soda, 11 lbs; fused protochloride of tin, 35 oz. A thin tinning is obtained by simple dipping, and one of any thickness by the aid of the battery.

Whitening by Tin.—This is effected by boiling for two or three hours in long copper troughs, crude cream of tartar with tin plates supporting a layer of about $\frac{1}{2}$ an inch of the pins, or other small articles, to be whitened. The whole charge is composed of alternate layers of pins and tin plates, so that each layer of pins is between two tin plates. This process will not succeed with iron without an intermediate coat of copper has been deposited.

GILDING. — *Gilding by Dipping.* — The baths employed contain gold in the form of a double salt of protoxide, and should possess little stability, that is to say, be decomposed and abandon the gold under feeble influences, and should dissolve the copper placed in them in an equivalent proportion to that of the deposited gold, thus forming a new double salt in which the copper is in the same degree of oxidization as the gold. When the articles have been previously amalgamated, it is mercury and not copper which is substituted for gold in the solution.

Preparation of the Gold Bath.—Distilled water, 17 pints; pyrophosphate of potash, or soda, 28 oz.; hydrocyanic acid of $\frac{1}{8}$ prussic acid, $\frac{1}{3}$ of an ounce; crystallized perchloride of gold, $\frac{2}{3}$ of an ounce. The pyrophosphate of soda is most generally employed, and is obtained by melting, at a white heat, the ordinary crystallized phosphate of soda. The pyrophosphate of soda may be obtained in the form of crystals, which is a proof of a definite composition. The quantity of chloride represents a little more than $\frac{1}{3}$ of an ounce of pure gold treated by aqua regia. Put 16 pints of distilled water in a porcelain vessel, or an enamelled cast-iron kettle, and add, by small portions at a time, and stirring with a glass rod, the pyrophosphate; heat, filter, and let it cool down. The chloride of gold is prepared by introducing into a small glass flask pure gold finely laminated, $\frac{1}{3}$ of an ounce; hydrochloric acid, pure, nearly 1 oz.; nitric acid, pure, $\frac{1}{2}$ an ounce. The flask is slightly heated, effervescence and abundant nitrous vapours result, and in a few minutes the gold has entirely disappeared, leaving a reddish-yellow liquor. The flask is then put upon a sheet of iron, with a hole in its centre, and supported by a tripod. The whole is heated by a gas or spirit lamp to evaporate excess of the acids; too much acidity may cause great irregularities in the working of the bath, and even prevent its action altogether. An excess of nitric acid causes a jumping of the heated liquors, and may overthrow the whole; it is preferable to have the hydrochloric acid predominating. The evaporation is finished when vapours escape slowly from the flask, and when the liquid has become of an oily consistency and of a deep red colour. The flask is then removed from the fire by wooden pincers, and set to cool upon a ring of plaited straw. If a more rapid evaporation is desired, heat the flask over ignited charcoal, or the spirit lamp; agitate the liquid to prevent any of the gold from returning to the metallic state. Well-prepared chloride of gold, when cold, forms a saffron-yellow crystalline mass. If the colour is red, it has been too much evaporated, and will do very well for electro-baths; but for dipping baths it must be heated again after a small addition of the two acids. If the perchloride of gold, by too protracted a heat, has passed to the state of insoluble protochloride, or even of metallic gold, the treatment must be begun again with the indicated mixture of pure

nitric and hydrochloric acids. The perforated sheet of iron, upon which the flask rests, is intended to prevent the action of heat upon the sides of the vessel, which will decompose the films of chloride of gold wetting the flask at these places. When the chloride of gold is cold and crystallized, dissolve it in the flask with a little distilled water, and pour the solution through a paper filter held in a glass funnel into a clean bottle; this is to separate a small quantity of silver always found in the gold of the trade. Rinse the flask and filter with the unemployed water, so as to get all the gold into the bath. Pour the filtered solution of chloride of gold into the cooled one of pyrophosphate, and stir with a glass rod. Lastly, add the hydrocyanic acid, and the bath is heated nearly to the boiling point for use. If the solution of pyrophosphate is still tepid, add the hydrocyanic acid before the chloride of gold. Hydrocyanic or prussic acid is not absolutely necessary; but, without it, the bath is too easily decomposed, and the gold is too rapidly precipitated upon the objects placed in it. When the solutions are mixed in the cold, the liquor is yellow or greenish-yellow; but becomes colourless by the increase of temperature. If the liquor becomes current red, or wine-lees violet, it is an indication that there is too little hydrocyanic acid; add it, drop by drop, until the liquor becomes colourless. An excess of this acid is objectionable, but there is a very simple method of keeping the baths in good working order, by adding prussic acid gradually to those too rich in gold; or correcting any excess of prussic acid with a small proportion of chloride of gold, until the gilding is produced without difficulty and of the proper shade. Thus prepared, the bath will produce very fine gilding upon well-cleansed articles, which must also have passed through a very diluted solution of nitrate of binoxide of mercury, without which the deposit of gold is red and irregular, and will not cover the soldered portions. The articles are supported by a hook or in a stoneware ladle perforated with holes, or in brass gauze baskets; they must be constantly agitated whilst in the bath. Gilders usually employ three baths, placed in close proximity to each other, and heated upon the same furnace; the first bath is one deprived of gold by a previous operation, and is used for removing all excess of acid which may remain upon the articles: the second bath still retains some gold, but not enough to give a sufficiently rich gilding. The pieces passed through it begin to receive the deposit, which will be finished in thickness and shade in the third bath. A gas furnace, easy to manage, and clean in its working, may be arranged by having a properly supported sheet-iron plate, with holes cut out where the kettles are to stand. Under each kettle place suitable gas burners; when the baths have been heated nearly up to boiling point, lower the gas, so as not to increase the temperature. This method produces much more gilding with a given quantity of gold, than one bath alone. The gilding is done in a few seconds; the finishing operations consist in rinsing in fresh water, drying in dry and warm saw-dust, and burnishing, if desired.

Colouring Process.—If the gilding is dull and irregular in colour, melt together in their water of crystallization, at about 212° Fahr., equal parts of sulphate of iron, sulphate of zinc, sulphate of alumina and potash, and saltpetre. Cover the articles with the mixture, and put them into a cylindrical and vertical grate. This is placed in the centre of a furnace, where the charcoal burns between the sides and the grate which holds the articles. When the moistened finger is presented to one piece, and a slight hissing sound is heard, the heat has been sufficiently raised; put all the articles rapidly into a very diluted solution of sulphuric acid, where the coating of salts is quickly dissolved; the articles present a warm, uniform shade of colour. If the copper articles are not entirely gilt by the first operation, the ungilt portions will show themselves by a red colouration, and the articles must then be deprived of gold, cleansed, and gilt

anew. Sometimes, when the first gilding is imperfect, instead of colouring by the process just described, the articles are placed for a few moments into the electro-bath. For articles which require a good plating there is an easy method by this process of obtaining as good results as by the battery; it consists in gilding several times, by dipping; before each dipping, the article is passed through the solution of nitrate of binoxide of mercury. Gilding by dipping is superior to that by electricity in depth of shade, brightness, and especially in not scaling off, as the deposit is of pure gold only.

Ormolu. — This operation consists in smearing, by means of a brush, the gilt and scratch-brushed objects with a thin paste of nitrate of potash, alum, and oxide of iron, which have been well mixed and ground under the muller, and to which has been added a solution of saffron, annatto, or any colouring substance, according to the shade desired. If the gilding is strong and thick, the objects are heated until the previous coating curls over at the approach of a wet finger. If the gilding is a mere film, the mixture is simply allowed to stand upon the articles for a few minutes. In either case, the whole is rapidly washed in warm water holding in suspension a certain quantity of the materials for ormolu; they are then rapidly dried, when they appear of a darker shade; remove any portions too much coloured by striking them vertically with a brush having long bristles. If the tint does not appear satisfactory commence the operation afresh, after washing off the ormolu in a diluted solution of sulphuric acid.

Green and White Gilding.— These shades may be graduated at will, and are obtained by adding, drop by drop, until the desired shade is arrived at, to the bath of double pyrophosphate of soda and gold, a solution of nitrate of silver. For the solution of nitrate of silver, dissolve in 5 oz. of distilled water, ½ oz. of nitrate of silver crystallized, or of lunar caustic. Before gilding green or white, yellow gild the objects in the ordinary bath, then pass them rapidly through the mercurial solution, and, lastly, dip them into the gold bath holding the nitrate of silver, which parts rapidly with its silver upon the first articles steeped in it. It is necessary to maintain the constancy of the shade by the addition of a few drops of the silver solution when required.

Gilding Silver by Dipping.—The silver articles, previously cleansed and scratch-brushed, are boiled for about half an hour in the gold bath of pyrophosphate, to which add a few drops of sulphurous acid, or, preferably, hydrocyanic acid, in excess of the quantity needed by the primitive bath. This gilding is very fine, but without firmness. The deposit is rendered more rapid and thicker when the silver articles are stirred with a rod of copper, zinc, or brass.

Gilding on Porcelain, Glass, or Crystal. —Mix first in a crystal mortar, and then between a muller and a ground plate glass, neutral chloride of platinum with rectified essence of lavender, so as to form a thin syrup, which is applied with a brush in very thin layers upon the glass, porcelain, or other ceramic object. After drying, heat in a muffle up to a dark red; this temperature reduces the platinum to the metallic state; it then appears with a perfect polish. After cooling, pass the whole object through aquafortis, which is without action upon the platinum, but destroys the impurities which may tarnish its surface. Rinse in plenty of water, wrap the object with a few turns of fine brass wire, having numerous points of contact with the platinized places, and dip into the gold bath. After a few minutes the platinum is covered with gold which has the same adherence and polish. Rub the gold with chamois leather; this method dispenses with burnishing, which is costly, and often impracticable in the deeply indented parts. If the gilding is too red, add to the bath a few drops of a solution of double cyanide of potassium and silver (liquor for silver electroplating). This method is preferable to that of baths with separate battery; the gilding has a bright instead of a dead lustre, and its adherence is greater.

Dutertre's Process for Bright Gold Gilding consists in applying with a brush to the objects a mixture of sulphide of gold and various essences, which are then submitted to a dull red heat.

Gold Dipping Bath with Bicarbonates.—The bicarbonate bath is prepared in a cast-iron kettle, turned clean and smooth inside on the lathe, and gilt by the protracted ebullition of nearly spent gold baths. Water $3\frac{1}{2}$ galls.; bicarbonate of potash or soda, $\frac{1}{3}$ oz.; pure metallic gold, transformed into chloride, $4\frac{1}{4}$ oz. The whole is boiled for at least 2 hours, and fresh water added to replace that evaporated. A part of the gold, in the form of a violet-black powder, precipitates, and requires the cooling and decanting of the liquor. This is boiled again and the gilding proceeded with, in the same manner as before described, except that the mercurial solution should be more diluted than for the baths of pyrophosphates. The operation is finished when about half of the gold in the liquor is deposited. The remainder goes to the saved waste. The bicarbonate process is inferior in most respects to the pyrophosphate, and is now rarely used.

Gilding by Diluted Bath.—This bath should be employed only as a complement to the cleansing process, before a more resisting gilding, as its results have little durability. Water, 2 galls.; bicarbonate of potash, 7 oz.; caustic potash, 63 oz.; cyanide of potassium, 3 oz.; metallic gold to be transformed into chloride, $\frac{1}{3}$ oz. The whole is brought up to the boiling point, and a pale gilding is obtained even upon articles imperfectly cleansed, and without using nitrate of binoxide of mercury. It is possible to add $\frac{1}{8}$ oz. of chloride of gold several times to this bath without any other substances. Afterwards maintain it at the proper strength by additions of gold and salts in the above proportions, and it will last for an indefinite period. This bath will gild about 140 oz. of small jewellery with $\frac{1}{30}$ oz. of gold, whereas a pyrophosphate bath gilds only about 35 oz. of small articles with the $\frac{1}{30}$ oz. of gold extracted from the liquor.

Gilding by Stirring and Gold Amalgam.—In the centre of a charcoal stove put a crucible holding a given quantity of pure and dry mercury, and when the temperature has reached about 212° Fahr. add $\frac{1}{8}$ the weight of gold. Stir with an iron rod until the amalgam has acquired the consistency of butter, throw it into cold water, and keep it there for use. Cleanse the articles to be gilded in aquafortis, put them in a stoneware pan, and pour over them a diluted solution of nitrate of binoxide of mercury, taking care to move the articles about all the time, in order to cover them with a regular white coating of mercury. Add the desired proportion of amalgam; on stirring the articles this is spread all over them. Then rinse the articles in cold water, place them in a large and deep copper ladle, perforated with numerous small holes, and having a long handle. Hold the ladle over a charcoal fire, and constantly stir it about in order to have the heat equal everywhere. The mercury of the amalgam is soon volatilized, and the gold remains adherent to the articles. If instead of a yellow gilding a red one be desired, this is got by waxing, which consists in pouring upon the pieces, kept in the ladle and upon the fire, in a well mixed and fluid state;—oil, 25 parts; yellow wax, 25; acetate of copper, 10; red ochre, 40. The articles must be constantly agitated, and the mixture allowed to burn out, when the whole is thrown into a very diluted solution of sulphuric acid. The waxing is only to be done after the complete volatilization of the mercury. When removed from the pickle, the gilding has the dull ochre appearance, and must be scratch-brushed. Small articles are brightened in a long narrow bag, where they are put with copper pearls, or the waste from these pearls, and wet with vinegar water; a to-and-fro motion is imparted to the bag, and the gilt articles and the copper granules polish each other. Rinse and dry in saw-dust, and burnish if required.

Cold Gilding with the Rag.—Dissolve finely laminated pure gold in aqua regia made of nitric acid, 5 parts; sal am-

moniac, 2; saltpetre, $\frac{1}{2}$. Heat carefully upon a gentle fire; when all the gold has disappeared, pour the cooled contents of the flask into a flat-bottomed stoneware pan. Into this liquor, place one upon the other, and in sufficient quantity, squares of linen cloth, strike them with a glass rod, in order that they may equally absorb the chloride of gold. Each square of cloth is taken out with wooden pincers, well drained, and spread for drying in a dark chamber. When nearly dry, each piece of cloth, supported upon glass rods, is placed on top of a charcoal fire, and soon takes fire. The combustion is aided by the presence of the saltpetre, and is finished upon a marble slab. Grind the ashes under a muller, collect and keep them between the folds of a parchment leaf, around which a wet cloth has been folded. The powder is then ready to use; mix it upon a slab with a few drops of water, and with this paste rub the well-cleaned surfaces of the silver to be gilt. The smooth surfaces are rubbed with the thumb, the fillets or grooves with a fine cork cut to the proper shape, and the corners or angles with a stick of soft wood, such as linden or poplar; the articles are then burnished. This gilding is very thin, but quite resisting, especially after the action of the burnishing tool, which forces the gold into the pores of the silver. If a red shade be desired, add a small proportion of pure copper to the gold to be dissolved in aqua regia.

Gilding with the Brush or with Shell Gold.—The gold powder is prepared by rubbing the cuttings of gold-beaters' foil under the muller; to prevent them from being blown away, add a small quantity of white honey. When fine enough put the paste into water, by which the honey is dissolved. After several washings, settlings, and decantings, allow the powder to dry. In case of hurry, the washing may be performed upon a paper filter. The dry powder is again ground with a little gummy water, and the paste spread over the inside of a mussel-shell. The gold powder is mixed with gum water, and applied with a brush upon the parts to be mended, and allowed to dry. If a green gold powder be desired, mix silver foil with the gold cuttings. An addition of rose copper foil produces a red gold. The preparation is the same for silver powder employed for mending slight defects in silver articles not exposed to friction.

Gold Electroplating.—It is not always necessary in electrogilding to use a battery, for the contact of two heterogeneous vessels, especially within a salt or acid liquor, is enough to produce electricity; thus it is sufficient to plunge the articles, attached by zinc wires, into gold baths prepared for the use of batteries, to have the operation taking place in the same manner as with a separate battery. Electrogilding in the cold is employed for large pieces, such as clocks; whilst electrogilding by heat is more adapted to the gilding of small articles, such as forks and spoons. The deposits produced by hot gilding are more smooth and clean, the colour is deeper, and the articles when removed from the bath may not require colouring; and with the same quantity of gold, gilding by heat is much more durable than that obtained from cold baths. Steel, tin, or lead can be gilt in hot baths, but not in cold.

Gold Electrogilding Baths. — 1. Distilled water, $2\frac{1}{5}$ gallons; cyanide of potassium, ordinary 70 per cent., $10\frac{1}{2}$ oz.; pure gold, $3\frac{1}{2}$ oz.; aqua ammonia, $17\frac{1}{2}$ oz. Heat the gold in a glass flask with 9 oz. of pure hydrochloric acid, and $4\frac{1}{2}$ oz. of pure nitric acid. When the gold is dissolved, continue the heat in order to expel the acid fumes, and until the colour of the liquid is dark red, nearly black. Remove from the fire, and dissolve the crystalline mass formed in cooling in 3 or 4 pints of water, and pour into a large porcelain dish. Add the ammonia, which produces an abundant yellow precipitate of gold ammonium; pour upon filtering paper, and the filtered liquid, which still contains traces of gold, is kept with the saved waste. Wash the precipitate remaining upon the filter several times

with cold water, until it no longer smells of ammonia. It must not be dried, as it is a fulminating mixture, and consequently very dangerous. Next dissolve in the vessel used as a bath the cyanide of potassium in the distilled water. Filter, and add the wet gold ammonium, which rapidly dissolves when stirred, and forms a clear gold bath. But before using it cold, the ammonia should be expelled by boiling for about one hour. For a newly-prepared cold electrogilding bath, the ordinary cyanide of potassium is preferable, on account of the potash it contains, which renders the liquor a better conductor of electricity. But for the preservation of the strength, the pure cyanide is better, as it possesses the advantage of a constant composition, and does not load the solution with foreign salts. The gold solution for maintaining the metallic strength of the bath is prepared as follows;—Transform the gold into precipitate of gold ammonium, as above described, place it in water, 2 pints of water to 4 oz. of gold, then add cyanide of potassium until the liquor is colourless. If there is not sufficient water with the gold ammonium, the liquor will be dark red, and will not be decolourized by cyanide. 2. Distilled water, $2\frac{1}{5}$ gallons; cyanide of potassium, pure, 7 oz.; or ordinary cyanide, according to strength, 10 to 14 oz.; pure gold, $3\frac{1}{2}$ oz. Make a neutral chloride of gold, as in the preceding formula, and, when cold and crystallized, dissolve it in $3\frac{1}{2}$ pints of water. Filter if needed. Dissolve the cyanide in 14 pints of water, filter, and mix the two solutions, which become colourless. When it is possible to boil this bath for half an hour before using it, it becomes a better conductor of electricity, and the gilding is more uniform. Its strength is maintained by additions of neutral chloride of gold and pure cyanide of potassium, from 1 to $1\frac{1}{2}$ of pure cyanide to 1 of gold. Both the above baths may be diluted with once or twice their volume of water; the gilding will remain fine, but the proportion of gold deposited will be less in a given length of time. 3. Yellow prussiate of potash, 7 oz.; pure carbonate of potash, 5 oz. sal ammoniac, 1 oz.; pure gold transformed into chloride, $\frac{1}{2}$ oz.; water, $2\frac{1}{5}$ gallons. Boil all the salts together, less the chloride of gold, separate by filtration the precipitate of carbonate of iron, then add the chloride of gold dissolved in a little water, and allow the bath to cool off. Any kind of gold salt, and the oxide, or even finely-powdered metal, may take the place of the chloride of gold; but the latter is preferred on account of the facility of its preparation, and of its solubility. Any kind of gold salt will be transformed into cyanide by the cyanide of potassium. The small proportion of the chloride of potassium resulting from the transformation of the chloride of gold into cyanide does not prevent the good working of the baths. The addition of a little prussic acid produces a brighter, but thinner, gilding. The indicated cyanides may be replaced by the cyanides of sodium, calcium, and ammonium. Cold gilding baths are generally kept in porcelain or stoneware vessels; but for large volumes of liquor use wooden troughs lined with gutta-percha plates. The sides of the troughs support anodes of laminated gold, which dip entirely into the liquor, and are held by small platinum wires; they are connected with the positive pole of the battery. Suspend the articles by means of metallic slinging wires to a movable frame of clean brass rods connected with the negative pole. The deposit of gold should be pure yellow, but it has sometimes a dull earthy grey colour. In that case scratch-brush it with the greatest care, and then pass it through the ormolu colouring. The gold anode conducts the electricity, and also maintains the metallic strength of the bath up to a certain point; but it is necessary to add now and then either the oxide or the chloride of gold, and a certain proportion of cyanide of potassium, to make up for that transformed into carbonate of potash and cyanide of ammonia. The proportion of cyanide is about double that of the chloride of

gold added; this is ascertained by the colour of the bath and the shade of the deposit; if the proportion of the chloride of gold is too great, add more cyanide. If gold predominates, the deposit is quite black or dark red; when the cyanide is in excess, the gilding is very slow and grey, and it will sometimes happen that pieces already gilt will lose their gold. When the bath is not in use, the gold anode must be removed from it, otherwise it will be dissolved. If the anode were partly immersed in the bath, it would be rapidly cut at the level of the liquid; for this reason use the platinum wires, which are not acted upon. It is remarkable that the solutions of cyanides, even without the action of the electric current, rapidly dissolve all the metals except platinum in the cold or at a moderate temperature, and that at the boiling point they have scarcely any action upon the metals. Cold electrogilding should be done slowly; and it is necessary to often look at the pieces in the bath, and scratch-brush those with an irregular deposit, or with dark spots. The intensity of the current should be often changed by increasing or diminishing the number of the elements, or the strength or the volume of the liquors in the battery. With too much intensity in the current, the deposit is black or red; it is yellow with the proper amount of electricity. With a weak current those portions opposite the anode only get covered with gold; it is well to change the position of the objects often, in order that the deposit be regular. With a freshly-prepared bath, it may happen that surfaces already gilt will lose their gold by changing their positions. This is a sign that the bath contains too much cyanide of potassium, and too little gold, or that the electric current is too weak. When the deposit obtained in cold baths is unsatisfactory in appearance, although the quantity is sufficient, the proper shade may be imparted by—1. The gilt article is steeped in a solution of nitrate of binoxide of mercury, until it has become white. It is heated afterwards to volatilize the mercury, and scratch-brushed. 2. Place the article into concentrated sulphuric acid, then heat it until abundant white fumes are disengaged, throw it, still hot, into a weak pickle of sulphuric acid. In this case, the acid has destroyed the organic impurities which may exist in the deposit, and reduces the subsalts of gold to the metallic state. 3. Smear the article with a thick paste of water and powdered borax, or with biphosphate of lime of the consistency of honey, and heat until igneous fusion takes place. Then put the article into diluted sulphuric acid, which dissolves the borax or the biphosphate, and leaves the gold with its natural bright lustre. When, after scratch-brushing small gilt articles, their colour is not entirely satisfactory, it may be improved by plunging the articles again into the bath but for an instant, and then immediately into boiling water. For gilding German silver, the solution should be worked at rather a low temperature, and with a less surface of anode. The solution should be just so weak in precious metal, that the German silver will not precipitate the gold without the aid of the battery; otherwise the deposit will take place so rapidly that the gold will peel off when being burnished or scratch-brushed.

Gold Electroplating in Hot Baths is more regular, more rapidly obtained, and possesses a deeper shade, than that by cold baths. 1. Crystallized phosphate of soda, 21 oz.; bisulphite of soda, $3\frac{1}{2}$ oz.; pure cyanide of potassium, $\frac{1}{2}$ oz.; pure gold, transformed into chloride, $\frac{1}{3}$ oz.; distilled water, $2\frac{1}{5}$ gallons. This is satisfactory for electrogilding silver, bronze, and other alloys rich in copper. For gilding wrought and cast iron and steel directly, without a previous coat of copper, the bath is modified as follows;—Distilled water, $2\frac{1}{5}$ gallons; phosphate of soda, $17\frac{1}{2}$ oz.; bisulphate of soda, $4\frac{1}{2}$ oz.; pure cyanide of potassium $\frac{1}{6}$ oz.; gold transformed into chloride, $\frac{1}{3}$ oz. The proportion of gold indicated is that of the metal employed, and it is not necessary to mind

the weight of the chloride, if the proper amount of gold is dissolved in aqua regia. Ten parts of metallic gold corresponds to about 18 parts of neutral chloride, or to 23 or 22 parts of acid chloride such as is usually sold. Steel articles, after cleansing by alkalies, must be passed rapidly through a very diluted solution of hydrochloric acid, wiped, and dipped into a very hot bath with an intense galvanic current at the beginning, which is gradually diminished by partly withdrawing the platinum anode. Small articles of steel, such as pens, or watch hands, are threaded on a thin brass wire, and separated one from the other by glass beads. After cleansing, they are put into the boiling bath, rinsed, dried, and polished in hot and dry saw-dust. It is preferable to give zinc, tin, lead, antimony, or the alloys of these metals, a previous coat of copper, or to begin the gilding in a hot gold electro-bath, nearly worn out, and to scratch-brush the articles carefully. The gilding is completed in a new hot bath, with a strong current.

Preparation of the Gold Bath.—1. Put four-fifths of the distilled water into a porcelain dish, or an enamelled cast-iron kettle, heated over a charcoal stove, and dissolve in it, by the aid of stirring, the crystallized phosphate of soda. When this is entirely dissolved, remove the liquor from the fire, filter if necessary, and allow it to cool off. 2. Place the gold in a glass flask, with ½ oz. of pure nitric acid and 1 oz. of pure hydrochloric acid. Heat slowly until the gold has dissolved, and then more rapidly to expel the excess of acid. There should remain a thick liquid of a blackish-red colour. Remove the flask from the fire, and by cooling the contents form a brown-red crystalline mass. The cooling is important. 3. Dissolve in a porcelain dish, in half the remaining water, the bisulphite of soda and the cyanide of potassium. 4. Then dissolve the neutral chloride of gold in the remaining water, and pour it slowly, stirring with a glass rod, into the cold solution of phosphate of soda; add the solution of bisulphite and of cyanide. The whole liquor soon becomes colourless; the bath is then ready. If the chloride of gold were thrown into the solution of phosphate of soda while hot, there would be danger of a partial reduction of the gold in the form of a metallic powder. The hot electrogilding baths for small quantities of liquor are kept in porcelain dishes, but for large baths use enamelled cast-iron kettles. The temperature may vary from 120° to 175° Fahr. Small articles, such as jewellery, are kept in the right hand with the conducting wire, and plunged and agitated in the bath. The left hand holds the anode of platinum wire, which is steeped more or less in the liquor, according to the surface of the articles to be gilt. Large pieces are suspended to one or more brass rods, and are not moved about. The gilding is very rapid, and a sufficient thickness is obtained after a few minutes. The shade of the gold deposit is modified by the amount of the platinum anode dipping into the liquor. If it dips but a little, relatively to the surface of the articles, the gilding is pale; by immersing it more the shade will become deeper and deeper, until it is red. The platinum anode is connected by a conducting wire to the positive pole of the battery, and the conducting wire starting from the negative pole, touches or supports the articles to be gilt. As a rule, it is preferable to replace the impoverished baths by fresh ones, instead of keeping up their strength by additions of metal, especially for small articles. When gilding large pieces, maintain the strength of the baths by successive additions of chloride of gold, or, what is better, of equal parts of gold ammonium and pure cyanide of potassium. In this manner baths may be made to last a long time, but they are open to the inconvenience of furnishing a red or green gilding, if many articles of copper or of silver have been gilt in them. Articles of copper, or its alloys, should be perfectly cleansed, and may be passed through a very diluted solution of nitrate of binoxide of mercury. Silver

requires to be heated, dipped, and perfectly scratch-brushed. For this metal the gilding should be strong, in order to prevent the corners and raised parts from becoming white and bare; and it is a good precaution to give it a coat of copper or brass, or a first gilding in an old bath. 2. Phosphate of soda, 14 oz.; bisulphite of soda, $3\frac{1}{2}$ oz.; bicarbonate of potash and caustic potash, $1\frac{3}{4}$ oz. of each; cyanide of potassium and pure gold for neutral chloride, $\frac{1}{2}$ oz. of each; distilled water, $2\frac{1}{5}$ gallons. All the substances except the chloride of gold may be dissolved together, and filtered if necessary; then the solution of chloride of gold is added. This bath is heated at from 120° to 140° Fahr., and produces a very fine gilding, but it requires an intense electric current. It does not suit for the direct gilding of iron or steel. 3. Yellow prussiate of potash, $5\frac{1}{4}$ oz.; carbonate of potash, pure, $1\frac{3}{4}$ oz.; hydrochlorate of ammonia, $\frac{2}{3}$ oz.; pure gold for neutral chloride, $\frac{1}{3}$ oz.; water, 1 gallon. Dissolve the first three salts in hot water, and filter the solution; after cooling add the gold solution, and boil for half an hour, taking care to replace the evaporated water. 4. Pure cyanide of potassium, $1\frac{3}{4}$ oz.; pure gold, for neutral chloride, $\frac{1}{3}$ oz.; water, 5 pints. Dissolve the chloride of gold in the whole of the water, and add the cyanide, which dissolves and makes the liquor colourless. This bath may be employed with little regard to temperature, and is simple in its ingredients. Unfortunately it is not uniform in its working, as it will ungild one face of the object while the other face becomes gilt, or may produce a red gilding at the bottom and a yellow one at the top. These inconveniences will partly disappear by a long ebullition.

Management of Hot Gold Baths.—The baths may be more concentrated, the quantity of water may be diminished, without changing the proportions of the salts and of the gold. But it is preferable to use diluted solutions, which deliver the metal in smaller quantity in a given time, but more homogeneous in substance. The articles should be kept in constant agitation; there is then no difference of specific gravity among the layers of the liquor, and the gilding possesses a uniform colour. A foil or a wire of platinum is preferred to a soluble anode of gold when electrogilding by the aid of heat, as it is not dissolved, and is more handy for regulating the intensity of the current, by immersing it more or less in the liquid. Thus with the same bath and battery three different shades can be obtained; a pale colour, with the anode dipping but slightly; a yellow colour, when the immersion is greater, and a red gold, if the whole anode is in the liquor. In a bath of pink gold, composed of gold, copper, and silver, by increasing or diminishing the length of the platinum anode in the liquor, the deposit will have a white, yellow, or red shade, as the various metals require different degrees of intensity for their reduction in the galvanic current. In hot electrogilding baths, and especially with small articles, keep them in the right hand constantly moving in the liquid, while the left hand is employed in changing the position of the platinum anode, so as to suit the surface and the nature of the articles, and obtain the desired shade. The hot baths may have their strength maintained by successive additions of chloride of gold with a proper proportion of the other salts; but it is preferable to wear out the bath entirely and to prepare a new one. When a bath is exhausted, the gilding is red if much copper has been gilt in it, and green in the case of silver articles. It may then be used for a first coat upon objects which are to be finished in a new bath. Thus green or white golds result from the simultaneous deposit of gold or silver in various proportions; red gold from the alloy of copper and gold; and pink gold from the combination of gold, silver, and copper.

Green and White Golds.—Add to one of the above baths a solution of the double cyanide of silver and potassium, or a diluted solution of nitrate of silver, until the desired shade is obtained. The tints will vary from a leek-green to a very pale whitish-yellow. This kind of

gilding mixed upon the same articles with red, yellow, or pink gold, will produce splendid effects of contrast, especially upon chased parts, where the green gold has a velvety lustre.

Red Gold.—Mix in suitable proportions the electro-copper bath already described with one of the baths for electrogilding; or use an old bath in which a great many copper articles have been gilt, with an intense current of electricity. Yellow gilding may be made to pass to red, by heating it after it has been covered with a paste of acetate of copper, cream of tartar, and common salt. Plunge the heated piece into a weak solution of sulphuric acid, and carefully scratch-brush afterwards.

Pink Gold or New Gold.—This kind of gilding is the most difficult to obtain on account of the different tendency of the various metals to galvanic decomposition. Pink gilding, to be perfect, should present at the same time the red, yellow, and white shades, in such a manner that a practised eye will distinguish them. The articles are first gilt yellow by the pyrophosphate bath for dipping, or by the hot electro-bath. Then, without drying, but keeping them in fresh water, small packages are made weighing from 1 oz. to 2 oz. each; pass lightly through the mercurial solution, and then red gilt in an old and hot bath, where a great deal of copper has already been gilt, or in a new bath composed of 10 parts of hot electrogilding bath, first formula, and 3 to 4 parts of the first coppering solution, with battery. For imparting the whitish tint of articles gilt by stirring and of the gold alloy for jewellery, the red gilding is passed through a boiling and nearly exhausted bath of pyrophosphate, to which add one-tenth, or a twentieth, or a thirtieth of its volume of a silver bath, or simply a few drops of a concentrated solution of nitrate of silver. In either case a blush of silver is deposited upon the red gilding. This gilding should be scratch-brushed or burnished, and may be chased, but the lustre soon disappears on account of the proportion of copper. To obtain the proper pink gilding, if the first deposit is unsatisfactory, plunge the articles for a few seconds into a mixture of 5 parts of sulphuric acid to 1 of nitric acid. The copper and silver are dissolved, and the yellow gilding reappears, upon which the operation may be begun anew. Besides the variations of colour in gilding due to the dipping of the anodes more or less into the bath, and to the strength of the electric current, moving the articles about in the bath will at all times enable the operator to vary the colour of the deposit from pale straw yellow to a very dark red. The temperature of the solution likewise influences the colour of the deposit, the colour being lightest when the solution is cold, and gradually becoming darker as the temperature increases.

Gilding Watch Parts. — In gilding small articles for watchmakers, gold is seldom directly applied upon the copper; there is generally a preliminary operation, called graining, by which a grained and slightly dead appearance is given to the articles.

Preparation of the Silver Parts. — Marks of the file are obliterated by a rubbing upon a wet stone, and lastly upon an oilstone. Any oil or grease is removed by boiling the parts for a few minutes in a solution made of 100 parts of water and 10 of caustic soda or potash; rinse in clean water, which should wet them entirely if all the oil has been removed. The articles are threaded upon a brass wire; cleanse them rapidly in the compound acids for a bright lustre, and dry them carefully in white wood saw-dust. The pieces are fastened upon the even side of a block of cork by brass pins with flat heads. The parts are then thoroughly rubbed over with a brush, entirely free from grease, and charged with a paste of water and very fine pumice-stone powder. Move the brush in circles, in order not to rub one side more than the other; thoroughly rinse in clean water, and no particle of pumice-dust should remain upon the pieces, or the cork. Next place the cork and the pieces into a weak mercurial solution, which very

slightly whitens the copper, composed of —water, $2\frac{1}{5}$ gallons, nitrate or binoxide of mercury, $\frac{1}{14}$ of an ounce; sulphuric acid, $\frac{1}{7}$ of an ounce. The pieces are passed quickly through the solution, and then rinsed. This operation gives strength to the graining which, without it, possesses no adherence.

Graining Powders.—1. Silver in impalpable powder, 1 oz.; cream of tartar, finely pulverized and passed through a silk sieve, 10 oz.; common salt, pulverized and sifted as above, 2 lbs. 2. Silver powder, 1 oz., cream of tartar, 4 to 5 oz.; common salt, white and clean, 13 oz. 3. Silver powder, 1 oz., cream of tartar, 3 oz.; common salt, white and clean, 2 lbs. All these substances should be as pure as possible, and perfectly dry. Cream of tartar is generally dry; common salt often needs, before or after it has been pulverized, a thorough drying in a porcelain or silver dish, in which it is kept stirred with a glass rod or a silver spoon. The mixture of the three substances must be thorough, and effected at a moderate and protracted heat. The graining is the coarser the more common salt there is in the mixture; and it is the finer and more condensed as the proportion of cream of tartar is greater, but it is then more difficult to scratch-brush.

Silver Powder.—The silver powder is obtained by immersing cleansed copper plates in a very diluted solution of nitrate of silver made with distilled water. The more diluted the solution is, the finer is the precipitate of silver upon the copper, and the more easily it is removed. In a glass or porcelain vessel $\frac{3}{5}$ of an ounce of crystallized nitrate of silver are dissolved in $2\frac{1}{5}$ gallons of distilled water, and 5 or 6 bands of cleansed copper $\frac{3}{4}$ of an inch wide are placed in it. These bands should be long enough to allow of a portion being above the liquid. The whole is kept in a dark place for 24 hours, and now and then stirred with the copper bands. This motion is sufficient to loosen the deposited silver, and present fresh copper surfaces to the action of the liquor. When no more silver deposits on the copper, the operation is completed, and there remains a blue solution of nitrate of copper. The silver powder is washed by decantation, or upon a filter, until there remains nothing of the copper solution. It is then carefully dried, avoiding contact with hard bodies. Nuremberg powder is produced by grinding a mixture of honey and silver foil upon a ground-glass plate with a muller until the proper fineness is obtained. The silver is separated by dissolving the honey in boiling water, and washing the deposited metal in a filter, until there is no remaining trace of honey. The silver is then carefully dried at a gentle heat.

Graining.—A thin paste made of one of the above powders and water is spread by means of a spatula upon the watch parts held upon the cork. The cork itself is placed upon an earthenware dish, to which a rotating movement is imparted by the left hand. An oval brush with close bristles, held in the right hand, rubs the watch parts in every direction, but always with a rotary motion. A new quantity of the paste is added two or three times, and rubbed in the manner indicated. The more the brush and the cork are turned the rounder becomes the grain, which is a good quality; and the more paste added the larger the grain. When the desired grain is obtained, the pieces are washed and then scratch-brushed. The wire brushes employed, which usually come from Nuremberg, are made of brass wires as fine as hair, very stiff and springy. It is necessary to anneal them upon an even fire to different degrees; one soft, or half annealed, for the first operation of uncovering the grain; one harder, for bringing up the lustre; and one very soft, or fully annealed, used before gilding for removing any marks which may have been made by the preceding tool, and for scratch-brushing after the gilding, which, like the graining, must be done by giving a rotary motion to the tool. Decoctions of liquorice or saponaire are employed in this operation.

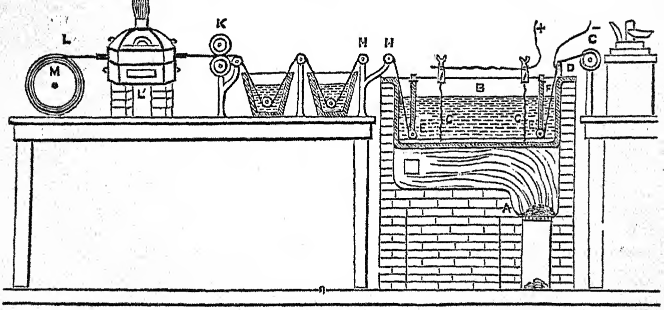
Resists.—1. If it happens that the same watch part is composed of copper and steel, this latter metal requires to be preserved against the action of the cleansing acids and of the graining mixture, by a composition called resist. This consists in covering the pinions and other steel parts with a fatty composition, which is sufficiently hard to resist the tearing action of the bristle and wire brushes, and insoluble in the alkalies of the gilding bath. Yellow wax, 2 oz.; translucent colophony, $3\frac{1}{3}$ oz.; extra fine red sealing-wax, $1\frac{1}{3}$ oz.; impalpable peroxide of iron or polishing rouge, 1 oz. Melt the colophony and sealing-wax in a porcelain dish upon a water bath, and afterwards add the yellow wax. When the whole is thoroughly fluid, gradually add the rouge, and stir with a wooden or glass rod. Withdraw the heat, but continue the stirring until the mixture becomes solid, otherwise all the oxide of iron will fall to the bottom of the mixture. The flat parts to receive this resist are slightly heated, and then covered with the mixture, which melts and is easily spread. For covering steel pinions, employ a small gouge of copper or brass fixed to a wooden handle. The metallic part of the gouge is heated upon an alcohol lamp, and a small quantity of resist is taken with it. The composition soon melts, and, by turning the tool around the steel pinion, this becomes coated. Use a scratch-brush with long wires, as their flexibility prevents the removal of the composition. When the resist is to be removed after gilding, place the parts in warm oil or into tepid turpentine, then into a very hot soap-water or alkaline solution, and, lastly, into fresh water. Scratch-brush and dry in warm saw-dust of white wood. The holes of the pinions are cleaned and polished with small pieces of very soft white wood, the friction of which is sufficient to restore the primitive lustre. The gilding of parts composed of copper and steel requires the greatest care, as the slightest rust destroys their future usefulness. Should some gold deposit upon the steel, it should be removed by rubbing with a piece of wood and impalpable pumice-dust, tin putty, or rouge. 2. Again, when it is desired to obtain gildings of several colours upon the same object, resists, generally made of some kind of varnish, are used; after having gilt an article of a uniform red or green colour, it is covered with a fat varnish, made drying by the addition of chromate of lead, at those places which are to resist the action of the new bath. By means of resists and successive baths, several different shades can be obtained upon the same object. The resist varnishes are applied with a brush or pencil, and should be thoroughly dried in a stove before placing the object into another solution. These varnishes may be coloured with various oxides or coloured salts, in order to facilitate their use upon those places which should be sharply marked; chromate of lead and artificial ultramarine blue are well suited for the purpose. Resist varnishes are also used for preserving the reverse parts of articles which have to receive the gilding only on the front. When the operation is finished, the resist is easily removed by a washing, first with essence of turpentine, gasoline, benzine, or benzole, and then with alcohol; when benzole is used, it is sufficient to wash the article in boiling water, and then to dry it in warm saw-dust of fir-wood. It comes out perfectly clean. This is not always the case with rectified turpentine, and it may be necessary to plunge the object into a hot alkaline lye, then to rinse and dry it in warm saw-dust.

Gilding.—After the preparations described, the gilding may be effected by some of the processes already mentioned. Hot baths must not be employed for those pieces covered with the resist. Heat $\frac{1}{8}$ of an ounce of finely laminated and pure gold in order to destroy all organic substance, dissolve in a glass flask with $\frac{3}{16}$ of an ounce of pure nitric acid, and $\frac{3}{8}$ of an ounce of pure hydrochloric acid. When the gold is dissolved, evaporate the excess of acids, leaving in the flask a syrupy dark-red liquid; the whole is then removed from

the fire and allowed to cool. Dissolve the chloride of gold in about 2 oz. of distilled water, and pour into a large glass vessel. Dilute with about a pint of distilled water, and pour into the liquor a certain excess of pure ammonia, which precipitates the gold in the state of a yellow powder of ammoniuret of gold, or fulminate of gold, which is a detonating powder when dry. The proportion of ammonia is sufficient, when a new quantity of this reagent, being added to the clear liquid above the settled powder, does not produce any new precipitate. The clear liquor is decanted and kept among the saved waste. Collect the settled powder upon a small filter, previously wetted with distilled water, there wash with distilled water until all ammoniacal smell has disappeared. The filter and its contents are afterwards put into a glass or porcelain vessel with a quart of distilled water and $\frac{3}{8}$ of an ounce of pure cyanide of potassium, which rapidly destroys the gold and passes through the filter. The whole is filtered again, boiled for 15 to 20 minutes, filtered again, and left to cool. The bath obtained is excellent for gilding the most delicate watch parts, with an electric current regulated to suit the surfaces to be gilt. Several of these baths, in various degrees of exhaustion, are generally kept in glass or porcelain vessels flat-bottomed, and holding from 7 to 9 pints within a depth of 4 to 5 inches. The articles to be gilt are suspended to metallic holders, connected with the zinc pole of a battery, and of a shape appropriate to the nature and form of the watch parts. One or more platinum wires are used for anodes, and are disposed in the centre or round the bath. The battery most generally employed is composed of three, four, five, or six small Daniell's elements. Those with balloons, on account of their constancy, should be preferred. The slower the gold deposit, the finer and more adherent it is. When the coating is sufficient, wash the articles in clean water, and fix again upon the cork in order to proceed to the last scratch-brushing with a decoction of liquorice, or of horse-chestnut.

Gilding Thin Wires.—Gilt silver is fine; gilt copper is half fine; and copper or brass alone, is false. At the present time, nearly all gilt wire is gilt by electricity; the baths and the batteries are the same as those already mentioned, but for the success of the operation a certain disposition of the apparatus is required. Upon a brick furnace A, Fig. 58, which may be heated either with solid fuel or gas, is a cast-iron enamelled kettle B, about 3 feet long, 18 inches wide, and 4 to 7 inches deep, for holding the gold bath. If gas is used as fuel, the burner should be an elliptic ring with 25 or 30 jets attached to it, or the same kettle may be used as a cold bath if desired, the fire being optional. At one end of

FIG. 58.



the apparatus, near the battery, are two wooden stands C, supporting an iron rod which passes through a certain number of wooden spools carrying the wire to be gilt. These spools turn freely upon the rod, and the unwound wires, before dipping into the bath, are pressed against a copper or brass rod D connected with the negative, zinc, pole of the battery; thus the wires are connected with this pole. The wires dip into the bath to about two-thirds of its depth, and are kept stretched by small grooved pulleys E E of glass, porcelain, or ivory, rolling freely upon glass or ivory axes, which are kept near the bottom by supports screwed on the top edges of the kettle. At the bottom of the bath, and crossing the wires to be gilt, are two or more platinum wires G G, the vertical branches of which communicate with the positive, or carbon, pole. These platinum anodes must nowhere touch wires to be gilt, as these two kinds of wire represent the two poles of the battery in the bath. At the other end of the apparatus is another series of wooden reels M, upon which the gilt wire is wound up. These reels are fixed to the square iron axis which traverses them, and which is turned by gearing, slowly enough to ensure a good gilding to the wire, during its passage through the bath. After passing through the gilding bath, the wires are rinsed and dried by winding over two wooden rollers H H revolving freely upon their axes, and plunged by means of grooved rollers into the first trough, filled with a weak solution of cyanide of potassium, which cleans and brightens the gilding; they then pass into the second trough filled with water, which is constantly replaced, which removes the salts from the wires. The drying rollers K, covered with several layers of calico, are moved by gear in opposite directions; the wires are thoroughly dried in a flat tube L, kept at a dull red-heat in the furnace L′. In a kettle of the size named, 20 wires may be gilt at the same time. Copper wires are generally previously silvered and passed once through a draw-plate, to avoid the cleansing process before gilding. The more intense the battery, or the slower the wires pass through the bath, so will the deposit of gold be increased; and it will be well to weigh the bobbins before and after the operation, for which purpose the spools for winding up and winding out should be of the same weight. This gilding requires constant supervision, either for uniting the broken wires, the severed parts of which may touch the anodes and stop the operation; or for regulating the intensity of the battery, which, if too powerful, will produce a red gilding, or, if too weak, a green gilding. Baths of double cyanide of gold and potassium are employed, cold or slightly tepid; baths with phosphate and bisulphite of soda are used for hot electrogilding, but they are concentrated until the proportion of water is one-half of that indicated. As the platinum anodes do not make up for the metallic loss of the bath, it is frequently necessary to add new portions of metal and salts, in the manner already described. Pure gold wire is sometimes gilt, in order to impart to it a more uniform and deeper shade. After being gilt, the wire is passed through the draw-plate or the rollers. By the draw-plate it is diminished by about one-fourth or one-half of a number to remove the dulness of the deposit, and bring up the lustre. When the gilt wire is flattened between the rollers, its surface is bright or dull, according to the state of the surface of the rollers. Silvering, or any other metallic electro-deposit upon thin wires, can be effected in a similar manner.

Gilding with a Dead Lustre.—1. By the slow deposit of a large proportion of gold. This gilding is very durable, but dull and earthy in appearance, and is costly. 2. By acids; giving a dead lustre to the metallic surface, before gilding, and by the processes indicated in the cleansing operations. This is employed for small articles, or when gilding by dipping, for bronze articles, or large embossed work. 3. With frosted silver, by depositing upon the object to be gilt a coat of frosted silver, and then

gilding in a good bath; this method is expensive, the burnished parts are greenish, and the intermediary coat of silver is more easily blackened by sulphur fumes than gold. 4. By copper, by depositing a solution of sulphate of copper decomposed by a battery a coat of this metal, which possesses a pink dead lustre. The whole is rapidly passed through the compound acids for a bright lustre, and the mercurial solution, and then gilt in a good bath. When the dead lustre obtained in the bath is perfect, the compound acids may be dispensed with, and merely place the article in the mercurial solution before it is gilt. This mode is generally preferred, as the gilding is very handsome in lustre and colour. The burnished parts will be red, if vinegar or soap-water is used; and of a fine yellow colour, if the burnishing tool be wetted with a decoction of flax-seed, or of marsh-mallow root. If the gold deposit is of insufficient thickness, it will blacken in time, by the oxidization of the intermediate coat of copper. 5. Dead lustre by mercury, or the old process of gilding by fire, which furnishes the most durable gilding, although costly.

Gilding by Fire or Mercury.—Mercury gilding will furnish gold with a bright or a dead lustre, scratch-brushed, ormolued, and with different shades. The amalgam of gold is prepared in the manner described in the process of gilding by stirring, only a little less mercury is used, in order to have an amalgam about as hard as wax. This amalgam is crystalline, and a certain crackling sound is heard when the crystals are crushed between the fingers. A stock of amalgam is generally prepared in advance, and is divided into small balls of nearly equal size, the value of which is ascertained from their number, and from the total weight of gold employed. These balls are kept in water, but should not remain too long without being used, as the different parts do not then present the same composition. The amalgam is spread with the finger upon a flat, hard stone, called the gilding stone; and having dipped a scratch-brush of stout brass wire into a solution of nitrate of binoxide of mercury until it becomes completely white, it is passed over the amalgam, a portion of which is carried away. The object, previously well cleansed, is scratch-brushed in every direction, and the brush must be frequently dipped into the mercurial solution to facilitate the regular and even spreading of the amalgam. This operation requires great care to obtain a uniform coat upon the hollow and raised parts. When the back part of a piece does not require gilding, the flat outline, and the back edge, should be gilt, so that the naked copper shall cause no injury in the subsequent operations. The article, when uniformly covered with the amalgam, is heated upon a charcoal fire without draught, which rests upon a cast-iron plate. It is advisable to employ a gilding forge, which allows the workman to watch the operation from behind a glass frame, which protects him from the mercurial vapours. The entire attention is now required for watching the process. With the left hand covered with a thick glove of buckskin, turn the piece in every direction upon the fire, and, as the mercury disappears, with the right hand strike the article in every direction with a brush, the handle and the bristles of which must be long to equalize the gilding, and to push the remaining amalgam upon those parts which appear less charged with it. When all the mercury has volatilized, the gilding has a dull greenish-yellow colour, resembling that of boxwood; examine whether the coat of gold is continuous. Should a few empty places appear, add more amalgam, and heat the whole again. The next operation is scratch-brushing, which furnishes a pale green colour, and requires another heating for arriving at the desired shade. The reheating should expel any remaining mercury, and produce a fine orange-yellow colour. In case a bright lustre is required, submit the object, with the aid of heat, to the ormolu process already described. To obtain dead lustre, the object is firmly fixed to an iron rod, by wire of the same

metal, and smeared with a hot paste for dead gilding, composed of saltpetre, common salt, and the double sulphate of alumina and potash. The whole is heated upon a brisk charcoal fire, without draught, and moved about until the mixture dries and begins to fuse, when the article is immediately placed in a barrel half filled with water. The covering of salts dissolves, and the dead lustre appears; this operation requires a certain amount of practice. The gilding must be strong to stand the dead lustre process, especially when the first trial is not successful. The red lines left by the iron wire disappear by plunging the object into a not too diluted solution of nitric acid, or pure hydrochloric acid. Mercury gilders do not employ pure gold; what they use is previously alloyed with a certain portion of copper or silver. With the latter metal the gilding is green. Red gilding is either obtained with a dark ormolu or with the green for red, already mentioned.

Gilding with a partly Dead, partly Bright Lustre.—1. Gild those parts with the amalgam which are intended for a dead lustre, and heat, scratch-brush, and reheat to the orange-yellow colour. Then, with the battery, give a sufficiently strong gold deposit to the whole, without regard to the parts already mercury-gilt; scratch-brush all the surfaces carefully, and smear the electro-gilt portions first with a thin mixture of water, glue, and Spanish white, and afterwards with a thick paste of yellow clay. After drying, cover the mercury-gilt portions with the paste for dead gilding, and proceed as already described. The Spanish white, &c., are dissolved in a dilute solution of hydrochloric acid. The glued paste is to preserve the electro-gilt portions from the heat; these are again wire-brushed with all the care necessary for not scratching the dead lustre. Brushing to finish. This method will sometimes produce red spots on those places which have been heated too much, or where the coat of gold was not thick enough. 2. Gild with the amalgam, and bring up the dead lustre upon those portions which are to receive it, and preserve them entirely with the resist varnish. After thorough drying, cleanse the object by dipping it into acids, in the usual manner, and gild in the electro-bath. The resist varnish stands all these acids and solutions. When the desired shade is obtained, dissolve the varnish with gasoline or benzine, which, unless there has been friction applied, does not injure either the shade or the velvety appearance of the dead lustre. Wash in a hot solution of cyanide of potassium, then in boiling water, and allow to dry naturally. The resist varnish may also be removed by allowing the object to remain for a time in concentrated sulphuric acid at 66° Baumé, which has n action whatever upon the gilding. In this case, washing with cyanide is unnecessary, pure water is sufficient. Gilding with a dead lustre, whatever process is employed, only suits those objects which will never be subjected to friction. Even the contact of the fingers injures it. A new freshness is imparted to old dead gildings by a washing in caustic lye, and then in a dilute solution of nitric or sulphuric acid. This process removes dirt, grease, dust, and smoke, but will not remedy scratches. In the latter case, the objects must be scratch-brushed, and then heated with the composition for a dead lustre.

Gilding Zinc with a Dead Lustre.—There is no artistic bronze, whatever the elegance and delicacy of its shape, which may not be reproduced in zinc with an accuracy which often deceives a practised eye. A great many articles have a simple coating of brass, bronzed afterwards to imitate similar objects of real copper, brass, or bronze; but others are gilt by mercury, either with a dead lustre, scratch-brushed, or burnished. With tin solder fill all the holes and the smallest defects which may exist in the zinc object, and, at the same time, remove all seams, burrs, and rough spots. Afterwards, scour the piece by passing it, for a few seconds only, through a boiling solution of 100 parts of water and 5 or 6 parts of caustic soda; if

left too long in this caustic lye it will spoil the polish of the zinc, which dissolves. After this scouring the object is rinsed in fresh water. It is then steeped for half a minute in a pickle composed of 1 part of sulphuric acid, and 10 parts of water, and lastly rinsed in boiling water. Then place the object in a cold or warm electro-bath of copper or brass, for a few moments, until it is covered with a thin metallic coating, which is deposited very uniformly if the object has in it no tin solder, and is perfectly cleansed; the deposit is black and dull on those parts which have been soldered, or imperfectly cleansed. In this case, thoroughly scratch-brush the article, and dip again into the electro-bath until the deposit is sufficiently thick. Most gilders use a warm bath for the first coating, scratch-brush, and complete the deposit in a cold bath. If a bright gilding is desired, the article may be rinsed in fresh water, and then dipped into an electrogilding bath.

Dead Lustre Gilding, equal in appearance to the best mercury gilding, is obtained—1. With silver. An electro-silvering bath is prepared by dissolving in $2\frac{1}{5}$ gallons of water, $5\frac{1}{4}$ oz. of fused nitrate of silver, and adding 9 oz. of pure cyanide of potassium; this at first produces an abundant precipitate, which soon dissolves. The filtered liquid is the silver bath, in which is steeped the zinc article previously coated with copper or brass. Under the influence of a proper electric current, the silver deposited is of a handsome frosted dead lustre appearance, and perfectly white. The object is then rapidly and thoroughly rinsed, and dipped into an electrogilding bath, of which we shall give the composition. The dead gilding by this process is very fine and silky, but is soon darkened by the sulphuretted hydrogen of the atmosphere and of gaslight, which sulphurizes the silver through the thin film of gold. 2. The galvanoplastic process is both more durable and more economical than that with silver. Add to the necessary quantity of water, one-tenth of its volume of sulphuric acid; in this dissolve as much sulphate of copper as it will hold at the ordinary temperature. This solution will mark from 20° to 24° Baume, then add enough water to reduce its specific gravity to 16° or 18°. This galvanoplastic bath is generally held in large vessels of stoneware, slate, wood, or gutta-percha; and porous shells are immersed in it, filled with a weak solution of sulphuric acid and of amalgamating salts. Plates or cylinders of zinc are put into these cells, and are connected by binding screws with one or more brass rods, which rest upon the sides of the trough, and support the articles which are to receive a dead lustre in this bath. The articles of zinc, previously coated with copper or brass, suspended to the rods, remain in the solution of sulphate of copper until they have acquired a satisfactory dead lustre. A few seconds after the articles have been placed in the bath, withdraw and examine them carefully; should the previous coat of copper or brass be insufficient to resist the corroding action of the acid solution of sulphate of copper, there is produced a muddy dark deposit, which is easily removed with the finger. Should this occur, the object must be scratch-brushed and placed again in the former alkaline baths of copper or brass, in order to increase the deposit which protects the zinc in the galvanoplastic bath. When the galvanoplastic dead lustre is successful, the deposit is perfectly regular, and of a pink shade which possesses great freshness. When it is irregular, marbled, crystalline, of a vinous or fire-red colour, and dull or earthy in appearance, these defects are due to the following causes; either the bath is in a bad state of conductibility or of saturation; or the surface of the zincs is too large in proportion to that of the objects, and therefore too much electricity is given out; or the previous electro-deposits of copper or brass were insufficient or inferior in quality. The remedy for either of these inconveniences is easily found out, and only requires a little care and attention. The galvanoplastic dead lustre being satisfactory, two preliminary operations are needed to ensure the success of the

gilding. They consist in rapidly passing the object, after rinsing, through a solution made of water, $2\frac{1}{5}$ galls.; nitrate of binoxide of mercury, $\frac{1}{3}$ of an oz.; sulphuric acid, $\frac{2}{3}$ of an oz.; then, after rinsing, place it in another solution composed of water, $2\frac{1}{5}$ galls.; cyanide of potassium, 14 oz.; nitrate of silver, $3\frac{1}{2}$ oz. The object acquires a slightly white tinge in this liquor, and is again rinsed in fresh water, before being put into the following gilding bath;—Distilled water, $2\frac{1}{5}$ galls.; phosphate of soda, 21 oz.; bisulphite of soda, $3\frac{1}{2}$ oz.; cyanide of potassium, pure, $\frac{1}{3}$ of an oz.; chloride of gold, neutral, $\frac{2}{3}$ of an oz. The mode of preparation of this bath is given in the receipt for hot gilding bath. This bath should be nearly boiling, and worked with an intense galvanic current. The anode is a platinum wire, which, more or less immersed in the liquor, allows of the regulation of the amount of electricity according to the volume, weight, and surface of the object to be gilt. This gilding requires an energetic electric action at the beginning; this is obtained by steeping the platinum wire deeply in the liquid, to have the entire surface of the piece covered instantaneously; as the thickness of the deposit increases, the anode is gradually removed from the bath until it only dips in a little. The gilding by this method has a remarkable freshness of tone. Before using the bath with battery, the zinc articles may be passed through a preparing bath; this is the same as a gold bath for dipping. Or the gilding may be done in two operations. After having deposited about half of the gold intended for the object, remove it from the bath, wash, pass again through the mercurial solution, and replace in the gold bath for finishing the gilding. After gilding, the articles are rinsed in clear boiling water for a few seconds to remove any saline matters; they are then dried in the stove, or in warm saw-dust of firewood. All friction should be carefully avoided, so as not to scratch the dead lustre. When parts of this gilding are burnished, their colour is green if the frosted surface has been obtained in the silver bath, and red if the galvanoplastic bath has been employed. These inconveniences are remedied by dipping the burnished article, for a short time, into the gold bath, this last deposit of gold must be so thin as not sensibly to impair the brightness of the burnished parts. Dead lustre electrogilding upon zinc will only suit such objects as have no friction to bear, and which are not often handled; it is especially useful for clocks and similar articles, which remain under glass. The dead lustre gilding here described can be applied to all metals and alloys, provided that those corroded by the solution of sulphate of copper be previously coated with copper or brass; these previous coatings are always desirable, as they prevent crystalline and irregular deposits often formed upon metals which are not corroded by the bath of sulphate of copper. The galvanoplastic dead lustre upon copper is much finer when the pieces have been previously covered with copper or brass in the alkaline baths. Faded gildings may be renovated by dipping them into a weak tepid solution of cyanide of potassium, and afterwards into very dilute nitric or sulphuric acid. Imperfect gildings may be removed by inverting the poles in a solution of cyanides, connecting the gilt articles with the positive pole, carbon or copper, and the negative pole, zinc, with the anode which becomes gilt. This process is employed for removing the gold from articles of iron, steel, and silver, which cannot be submitted to the ungilding bath. Silver, copper, and brass may also be removed by similar processes.

Dissolving Gold from Gilt Articles.—Iron and steel articles are ungilt, without any injury to themselves, by dipping them into a bath of 10 parts of cyanide of potassium and 100 parts of water and connecting them with the positive pole of a battery. A wire or foil of platinum is fixed to the negative pole. This is inverting the position of the poles; and in this case the gold applied upon the iron or steel is dissolved in the

solution of cyanide, and partly deposited upon the platinum anode, from which it is removed in a regular gold bath. When there is only a film of gold upon iron or steel, it may be removed by the cyanide alone, without the aid of electricity, but this method is slow. Silver, copper, and their alloys may also be ungilt by this process; but the cyanide dissolves, at the same time, the gold, and part of the other metals; it is therefore preferable to operate as follows;—For ungilding silver, it is heated to a cherry-red heat, and immediately thrown into a pickle of more or less diluted sulphuric acid. The gold scales off, and falls to the bottom in the shape of spangles. The operation is repeated until gold no longer appears upon the surface of the silver, which is then white and frosty. This process is not adapted to light and hollow articles, for which the preceding process is better. For copper and its alloys, in small articles, such as false jewellery thinly gilt, either by battery or by dipping, use the following bath;—1. Sulphuric acid, 10 parts; nitric acid, 1 part; hydrochloric acid, 2 parts. The large quantity of sulphuric acid allows of the solution of gold, whilst it does not sensibly attack copper or its alloys. The sulphuric acid is put alone into a stoneware jar, and the mixture of hydrochloric and nitric acids, kept in a stoppered bottle, is gradually added to it as the operation proceeds. The same sulphuric acid may last a long time, if it is kept well covered, and its dissolving action promoted by successive additions of nitric and hydrochloric acids. The articles should be often withdrawn to watch the operation, which is terminated when no gold is seen, and when the copper has acquired a uniform blackish-grey coat; or by plunging the objects into the compound acids, they will be perfectly cleansed when the gold has all dissolved. 2. Saltpetre and common salt may be substituted for nitric acid and hydrochloric acid; the salts must be finely powdered, and stirred with a glass rod. 3. For large objects, such as clocks or chandeliers, concentrated sulphuric acid, 66° Baumé, is put into a glass or stoneware vessel supporting two brass rods. One of these rods is connected by a conducting wire with the last carbon of a battery of two or three Bunsen's inverted elements, and supports the objects to be ungilt, which are entirely covered by the sulphuric acid. The other rod supports a copper plate facing the object, and is connected with the last zinc of the battery. The electric fluid traverses the sulphuric acid, and carries the gold from the positive to the negative pole; as the copper plate is not prepared for retaining the gold, it falls to the bottom of the bath in a black powder, which is easily recovered. So long as the sulphuric acid is concentrated, and even under the action of the galvanic current, it does not sensibly corrode the copper; and as it rapidly absorbs the dampness of the atmosphere, the vessel in which it is contained should be kept perfectly closed, when the ungilding process is not in active operation; and the pieces for ungilding should be put in perfectly dry. If it is intended to sacrifice the gilt articles of copper or silver, let them remain in pure nitric acid, which dissolves all the metals except gold, which either floats at the surface of the liquid as a metallic foil, or falls to the bottom as a blackish powder. If the liquor is diluted with distilled water, and filtered, all the gold will remain on the filter, and the solution will contain the other metals.

SILVERING.—*Whitening with Silver in a Pot.*—This operation is still employed for whitening small wares for which durability is of secondary importance, and which simply require the whiteness of silver; such are hooks and eyes, or buttons. This whitening is made as follows;—1. Dissolve a certain quantity of pure granulated silver in double its weight of pure nitric acid. The solution is largely diluted with water, and the metal is precipitated in heavy white clods by common salt or hydrochloric acid. All the nitrate of silver has been decomposed when a further addition of hydrochloric acid or common salt to the clear supernatant liquid does

not produce any turbidness. The clear liquors are then thrown away, and the chloride of silver obtained is washed several times, to deprive it of all free acid. If this precipitate is to be kept some time before use, it should be removed from the sunlight, which blackens it rapidly. The chloride of silver, with a little water, is thoroughly mixed with at least 80 times its weight of finely powdered bitartrate of potash, and kept in a stoneware pot. 2. Pure silver for making the chloride, 1 part; powdered cream tartar, salt, 83 parts of each; a few spoonfuls of the paste thrown in, and dissolved in boiling water contained in a pure copper kettle. The articles are dipped into this bath by a hook, or in a basket of wire gauze, such as indicated in receipt for gilding by dipping. Or have another basin of copper, shallow and perforated with holes, which rests against the upper sides of the kettle. By means of handles, this basin can be removed at once with its contents. Stir the articles with a wooden spatula; and at each operation add a quantity of paste, proportioned to the surfaces to be whitened. These baths do not work well when freshly made, but improve as they are more used. They acquire a dark green tint, due to the copper which is dissolved, and which takes the place of the deposited silver. Varnishing, colouring, and cleansing may be done in aqua fortis; but these cleansing methods are inferior to those employed for gilding; in general, use the worn-out acids of gilders. Brighten the articles by friction with saw-dust. The smallest particle of iron, zinc, or tin introduced into the whitening bath imparts a red colour to the brass or copper articles in the liquor. The iron is separated by a magnet; the zinc is dissolved in pickles of hydrochloric or sulphuric acid, which, when cold, do not sensibly corrode the copper articles; tin or lead must be picked out by hand. If the operation has not succeeded, the articles are plunged for a few seconds into a boiling solution of water, $2\frac{1}{5}$ galls.; nitrate of silver, $3\frac{1}{2}$ oz.; ordinary cyanide of potassium, 21 oz. This bath retains its strength for a long time, and increases the brightness and whiteness of the deposit. The process of silvering by dipping has nearly superseded this method.

Plated Silver is obtained by rolling together a plate of copper of the first quality, and one of silver; these are either welded, or simply united by placing their hot and clean surfaces together, wetted with a concentrated solution of nitrate of silver. The two metals are reduced and drawn out about equally by the pressure of rolls, and long sheets or bands of silvered metal are thus obtained, with which a great many articles may be manufactured. By this mode of operation, a great quantity of material is lost, as the objects have to be cut out from a sheet entirely silvered, and the waste retains a large proportion of that metal; the cut sections present parts without silver, which must be hidden by ledges, or by silvering by another method. There is also the absolute necessity of employing pure copper, which is more costly, less sonorous, and not so tough as its alloys; but the greatest defect of the process is the difference of thickness of the silver, according to the shape of the object. Raised surfaces are the most exposed to friction, and it is just there that the coat of silver is the thinnest; the conditions are reversed with electro-silvering, and the parts in relief receive a more abundant deposit of silver, which is a satisfactory result. The best plated silver is manufactured by applying upon an ingot of pure copper weighing 9 parts, another ingot of pure silver weighing 1 part, to coat one side only; add another part of silver, if it is intended to coat both sides. The two are rolled together until the desired thickness is obtained. The silver of the plated metal will be bright if the rollers are well polished, and dull with rough rollers. The only solder which does not injure plated silver is tin solder; and when the objects manufactured are required to resist a warm temperature, nuts and screws are employed. The electroplating of old wares made from copper with a covering of silver, is often difficult. Supposing it is required to electroplate an old cruet-stand, the

bottom is separated from the wire, either by unsoldering or unscrewing. Smooth by emery cloth, or pumice-stone and water, or by powdered bath-brick brushed over with a hard brush. Spots of verdigris are removed with a few drops of hydrochloric acid. The great difficulty consists in giving a good electro-deposit upon the edges or mounts where there may be some lead or lead solder; apply to such parts, with a rather soft brush, a solution made by dissolving 4 oz. of mercury in nitric acid, and adding about half a pint of cold water. This solution is lightly brushed over the lead mounts only; the article and brush are then to be well rinsed, and the brush and plain water applied in the same way. The solution of mercury will turn the edges black, or dark grey, but the subsequent brushing will render them bright again. The frame when well rinsed is ready for the depositing bath. If, on its first immersion, any black spots appear, the frame may be removed, again brushed over, and finally returned to the bath. If the edges do not receive the coating of silver as readily as the other parts, the solution may require a little more cyanide, or a greater battery power, or an increase in the surface of the anode. These lead edges may be prepared for receiving the silver deposit by a previous coat of copper applied as follows;—The edges are plunged into a solution of sulphate of copper, with a little free sulphuric acid in it; then, by touching the lead edge with an iron wire, it is immediately coated with a bright deposit of copper, which is rinsed and becomes a good conductor for the further electro-deposit of silver. The coating of tin underneath the bottom of cruet frames is very difficult to plate, unless in a solution made expressly for it; therefore it is preferable to remove it either with abrading materials, or with nitric acid employed with care. This process of depositing copper will be found useful not only for old plated ware, but also for many articles on which are found unruly spots of tin solder.

Silvering with Silver Foil.—This method is never practised except upon objects already manufactured, in their definite shape; and is adapted to all kinds of copper, bronze, or brass. It is, in certain respects, superior to plated silver; but is very difficult of execution, and has less adhesion to the metal underneath. After annealing the articles, they are thrown whilst hot into a bath of sulphuric acid with a small proportion of hydrochloric and nitric acids. They have then a dull and dead lustre, owing to a multitude of small holes, which are so many points of attachment for the silver foil. The objects, thus prepared, are tightly fixed upon an iron rod, which is held in a vice. Their temperature is raised to about 300° F., by means of incandescent charcoal put at the proper place, so as to open the pores of the metal, which, by cooling afterwards, will imprison the silver applied. The silver foils, taken from the book with small tweezers, are cut to the proper size upon a cushion with an ivory or steel knife. After each foil is deposited upon the object, it is made to adhere by a light pressure of a rag pad, and afterwards by the friction of a steel burnishing tool. The parts of the silver foil which do not adhere are removed with a soft brush. Gold-beaters prepare silver foil either with bright or dead lustre. The latter is made to adhere only by the pressure of the pad, and not by the burnishing tool. This dead lustre cannot compare in fineness with that obtained by the battery; however, it resists handling and the sulphur gases of the atmosphere better. Articles thus silvered are only burnished after all the silver foils have been applied; round or cylindrical objects are burnished upon the lathe, other forms by the hand; there are always places and lines showing the vibrations of the burnishing tool. This method of silvering is only employed for very large objects, such as high chandeliers and other church ornaments. Spoons and forks may be covered with silver foil, as follows;—First slightly silver with a dead lustre in a silver bath by dipping, heat, and then cover with silver foil, by the pressure of an iron scratch-brush striking vertically, forcing the silver foils

into the pores of the metal underneath. Burnish by the usual method; it is impossible to obtain a dead lustre by this method.

Cold Silvering by rubbing, with the thumb, a cork, or a brush. The results are better than those by the whitening process, but not very durable; the method is useful to repair slight defects upon more durable silverings, and to produce mixtures of gold and silver, or gold, upon slightly gilt objects, thus avoiding the use of resist varnishes. Make a paste by thoroughly grinding in a porcelain mortar or with a muller, and, as far as practicable, not in the light;—1. Water, $3\frac{1}{2}$ to 5 oz.; white fused nitrate of silver, or, preferably, the chloride, 7 oz.; binoxalate of potash, $10\frac{1}{2}$ oz.; bitartrate of potash, $10\frac{1}{2}$ oz.; common salt, 15 oz.; sal ammoniac, $2\frac{3}{4}$ oz. 2. Chloride of silver, $3\frac{1}{2}$ oz.; bitartrate of potash, 7 oz.; common salt, $10\frac{1}{2}$ oz. When finely pulverized in a porcelain mortar, triturate it under a muller upon a plate of ground glass until there is no granular feeling. Keep the paste in a porcelain pot, or in a black glass vessel, to preserve it from the light, which decomposes it rapidly. When about to use it, add a little water so as to form a thin paste, which is applied with a brush or pencil upon the cleansed articles of copper, or upon those gilt by dipping, or even upon those gilt by the battery, provided that the coating is thin enough to allow the copper to decompose the silver paste through the coat of gold; allow the paste to dry naturally, or with the aid of a gentle heat. The chemical reaction is more or less complete, according to the thickness of the gold deposit, and the dry paste is of a pink shade, or entirely green. The salts are removed by a thorough rinsing in cold water, and the silver appears with a fine frosted appearance, the brightness of which may be increased by a few seconds' immersion in a very diluted solution of sulphuric acid, or of cyanide of potassium. This silvering bears the action of the wire brush and of the burnishing tool very well; and it may also be oxidized. Should a first silvering not be found sufficiently durable, after scratch-brushing, apply a second or a third coat. This silvering is not so adhering or white on pure copper, as upon a gilt surface. For the reflectors of lanterns the paste is rubbed upon the reflector with a fine linen pad; then, with another rag, a thin paste of Spanish white, or similar substance, is spread over the reflector and allowed to dry. Rubbing with a fine and clean linen rag will restore the lustre and whiteness of the plated silver.

For Plated Silver Reflectors—A bath made of water, $1\frac{3}{4}$ pint; nitrate of chloride of silver, 2 oz.; cyanide of potassium, $10\frac{1}{2}$ oz. Add sufficient Spanish white, or levigated chalk, in fine powder, to produce a thin paste, which is kept in a well-closed pot. This paste is spread by a brush or a pad of old linen, all over the surface of the reflector, and allowed almost to dry, when it is briskly rubbed over by another clean dry rag of old linen.

Silvering by Dipping in a Warm Bath.—For small articles a bath is made by dissolving in an enamelled cast-iron kettle in 2 galls. of water $17\frac{1}{2}$ oz. of ordinary cyanide of potassium. Also dissolve $5\frac{1}{4}$ oz. of fused nitrate of silver in $1\frac{3}{4}$ pint of water contained in a glass or porcelain vessel. The second solution is gradually poured into the first one. Stir with a glass rod. The white or greyish-white precipitate produced soon dissolves, and the remaining liquor is filtered if a perfectly clear bath is desired. When brought to the boiling-point it will immediately silver the cleansed copper articles plunged in it. The objects must be quickly withdrawn. The silvering should immediately follow the cleansing, although the rinsings after each operation should be thorough and complete. This bright and light silvering is adapted for set jewellery, which cannot be scratch-brushed without flattening the clasps, and to which a bright lustre is absolutely necessary as a substitute for the foil of burnished silver placed under the precious stones of real jewellery. The employment of the solution of nitrate of binoxide of mercury is useless, and even injurious, for this

bath. It is useless to keep up the strength of the solution by new additions of cyanide and silver salt; thus reinvigorated, it gives results far inferior to those of the former solution. The bath should, therefore, be worked out as long as the silvering is satisfactory, and when exhausted, put away with the waste. With this process a battery and a soluble anode may be used to obtain a more durable deposit; but the operation is no longer a simple dipping, and properly belongs to electro-silvering by heat. A solution which, when boiling, produces a very fine silver coat, with a dead, or partly dead, lustre, upon cleansed coppers, is made by dissolving with the aid of heat, in a well-scoured copper kettle, distilled water, 9 pints; ferrocyanide of potassium, 21 oz.; carbonate of potash, 14 oz. When the liquid boils add the well-washed chloride obtained from 1 oz. of pure silver. This should boil for about half an hour, and be filtered before using; part of the silver deposits upon the copper kettle, and should be removed when a new bath is prepared. On account of this inconvenience the process has been nearly abandoned, although the products are remarkably fine. All the dipping silvering baths, which contain a comparatively great excess of cyanide of potassium to the proportion of the silver salt, will silver well copper articles perfectly cleansed, even in the cold; whereas this property diminishes in proportion to the increase of the amount of silver in the bath, or with the decrease of the amount of cyanide. For small articles, partly copper and partly iron, such as those used for saddlery and carriage wares, a particular process of silvering is used. The bath is composed of;—Water, 9 pints; caustic potash, 6 oz.; bicarbonate of potash, 3½ oz.; cyanide of potassium, 2 oz.; fused nitrate of silver, ⅔ oz. The cyanide, caustic potash, and bicarbonate are dissolved in 7 pints of water in an enamelled cast-iron kettle, then the remaining quart of water, in which the nitrate of silver has been separately dissolved, is added to the former solution. For the silvering operation a certain quantity of articles is cleansed, thoroughly rinsed, and put into a small enamelled kettle. Enough of the silver bath is poured in to cover the articles entirely, and the whole is brought to a boil for a few seconds, and stirred with a wooden spatula. When the silvering appears satisfactory, the liquor employed is put with the saved waste; the same liquid is never used for two batches of articles. This process gives a somewhat durable silvering with a dead lustre, of a greyish white, which is increased in whiteness and brightness by soap and burnishing.

Silvering by Dipping in a Cold Bath.—As the bath is cold it is always ready for use, and the deposit is finer and more unalterable, because only chemically pure silver is deposited, without any mixture of subsalts. The bath is formed of bisulphite of soda, to which is added nitrate of silver, until it begins to be dissolved with difficulty. It is therefore with a double sulphite of soda and silver that the cold silvering by dipping is effected. Bisulphites of potash, ammonia, and other alkalies may be substituted for the bisulphite of soda, but the latter is to be preferred, because its preparation is cheaper, more easy, and better known.

Preparation of Bisulphite of Soda for Cold Silvering.—Put into a tall vessel of glass or porcelain, water, 10 pints; crystallized carbonate of soda, 10 lbs. Pour a little mercury into the bottom of the vessel, so that the glass tube carrying sulphurous acid gas, which has to be placed into it, may not be stopped by the crystals formed during the operation. Arrange an apparatus for the production of sulphurous acid gas, and let the washed gas pass through the vessel holding the carbonate of soda. Part of the soda is transformed into sulphite of soda, which dissolves, and a part falls to the bottom as bicarbonate. The latter is, however, transformed into sulphite of soda by a continuous production of sulphurous acid, and the carbonic acid escapes. When all has dissolved, continue the passage of sulphurous acid until the liquid slightly red-

dens blue litmus paper, and then put the whole aside for 24 hours. After that time some crystals are found upon the mercury, and the liquid above, more or less coloured, is the bisulphite of soda for silvering. The crystals are separated from the mercury, drained, and kept for gilding baths. They are not suitable for silvering. The liquid bisulphite of soda thus prepared, should be stirred with a glass rod, to throw off the carbonic acid which may still remain. The liquor should then be again tried with blue litmus paper. If it turns a deep red, add a little carbonate of soda for neutralizing the excess of sulphurous acid; if red litmus paper becomes blue, there is too much alkali, and more sulphurous acid gas should be passed through the liquid, which is in the best condition when litmus paper becomes violet or slightly red. This solution marks from 22° to 26° Baumé, and must not come in contact with iron, zinc, tin, or lead.

Cold Silvering Bath for Dipping.—A stoneware or glass vessel is about three parts filled with the liquid bisulphite of soda, a solution of nitrate of silver in distilled water, of medium concentration, is gradually added while the bath is continually stirred with a glass rod; a white flocculent precipitate of sulphite of silver is produced by stirring; this is dissolved by the bisulphite of soda. The silver solution is added so long as the precipitate readily disappears, and stopped when it becomes slow to dissolve. This bath is always ready to work, and instantaneously produces a magnificent silvering upon copper, bronze, or brass articles which have been thoroughly cleansed, and passed through a weak solution of nitrate of binoxide of mercury, although this last operation is not absolutely necessary. According to the length of time of the immersion the bath will give, a very fine whitening by silver is as cheap as any of the other described processes. A bright silvering, especially adapted for setting jewellery; or a silvering with a dead lustre, still more durable, without electricity, and in the cold. The loss of silver is made good by additions of nitrate of silver. When the proportion of bisulphite is not sufficient to dissolve the metallic salt, add some bisulphite of soda to restore the bath to its primitive state. Silver is slowly deposited upon the sides of the vessel; this may be dissolved in nitric acid for future uses.

Solution of Silver or Gold for Silvering or Gilding without the Aid of a Battery.—1 oz. of nitrate of silver is dissolved in 1 quart of rain or distilled water, and a few crystals of hyposulphite of soda are added which form a brown precipitate soluble in a slight excess of hyposulphite. Small articles of steel, brass, or German silver may be silvered by dipping a sponge in the solution and rubbing it over the surface of the article to be coated. A solution of chloride of gold may be treated in the same manner, and applied as described. A more concentrated solution of either gold or silver may be used for coating parts of articles which have stripped or blistered, by applying it with a camel-hair pencil to the part, and touching the spot at the same time with a thin clean strip of zinc.

Silver Electroplating.—*Bath.*—Water, $2\frac{1}{2}$ galls.; cyanide of potassium, pure, $17\frac{1}{2}$ oz.; pure silver for cyanide, $8\frac{3}{4}$ oz. The composition of commercial cyanide of potassium is exceedingly irregular. The pure, or No. 1, contains from 90 to 100 per cent. of real cyanide, and is especially employed for gilding and silvering baths. No. 2 contains from 60 to 70 per cent. of real cyanide; it is the article prepared by Liebig's method, and is used for electro-baths of copper and brass. No. 3, which marks from 55° to 60°, is for scouring and preparing baths, and for photographic operations. 1. Put in a porcelain dish, holding a quart, pure granulated silver, $8\frac{3}{4}$ oz.; pure nitric acid at 40° Baumé, $17\frac{1}{2}$ oz. Heat by charcoal or gas. The dish should be supported by an iron triangle, and not in direct contact with the fire. The acid rapidly attacks and dissolves the silver with an abundant production of yellow nitrous vapours, which must not be

inhaled. When the vapours have disappeared, there remains a liquid more or less colourless, according to the proportion of copper held by the commercial silver, which is seldom entirely pure. The heat is then increased in order to evaporate the excess of acid, which escapes in white fumes. The material in the dish swells up and dries, and, with a further increase of heat, melts like wax. The dish is then removed from the fire, and being held with a cloth, the molten mass is made to flow upon the sides, where it soon solidifies; the fused nitrate of silver, lunar caustic, is more or less white, or grey, according to the purity of the silver employed. When perfectly cooled, turn the dish upside down, and by a gentle tap on the sides, the mass is detached. 2. Dissolve the nitrate of silver in ten or fifteen times its weight of distilled water; hydrocyanic acid poured into this solution immediately produces an abundant white precipitate of cyanide of silver. A sufficient quantity of prussic acid has been employed when, by adding a few drops of it to the clear liquid, no precipitate or turbidity appears. Throw the liquid upon a filter of calico stretched on a wooden frame, the cyanide of silver remains on the cloth, the solution with the nitric acid and excess of prussic acid passes through. Wash the precipitate left upon the filter two or three times with pure water. 3. This cyanide of silver is put into the vessel intended for the bath, and stirred with the $2\frac{1}{5}$ galls. of water. The cyanide of potassium is then added, dissolves it, and also dissolves the cyanide of silver, thus giving a solution of a double cyanide of potassium and silver. Those who employ small baths, often renovated, may substitute for the cyanide of silver the chloride, or the nitrate of this metal. In the latter case, the quantity of cyanide of potassium should be increased. Such baths will be prepared as follows; —1. The nitrate of silver is prepared in the manner indicated above, and $5\frac{1}{4}$ oz. of it, nearly equal to $3\frac{1}{2}$ oz. of pure silver, are dissolved in $2\frac{1}{5}$ galls. of water. 2. The cyanide of potassium No. 1, about $8\frac{3}{4}$ oz., is then added. Stir to facilitate the solution, filter the liquor, to separate the iron contained in the cyanide. This operation may in some cases be dispensed with, because the iron rapidly falls to the bottom of the bath, and the solution becomes limpid. The proportion of cyanide of potassium employed is more than is required for dissolving the silver, as $1\frac{1}{2}$ part of good cyanide is sufficient for 1 part of silver; but unless there is an excess of cyanide of potassium, the liquors do not conduct electricity well, and the deposit of silver is granulated and irregular. The silvering is effected with a battery, and with baths either warm or cold. The latter method is generally adopted for articles which require great solidity. The hot process is used for small articles, and is preferable for steel, iron, zinc, lead, and tin which have been previously electro-coppered. The hot baths are generally kept in enamelled cast-iron kettles, and the articles are either suspended, or moved constantly about in them. The preliminary cleansing in acids, and passing through the mercurial solution, are necessary. A somewhat energetic current is needed, especially when the articles are moved about, in order to operate rapidly. There is too much electricity when the articles connected with the negative pole of the battery become grey or black, and produce many bubbles of gas. A platinum, large wire or thin foil anode, is generally preferred to the soluble anode of silver employed in cold baths, but the solution is rapidly impoverished. In hot silvering baths, the separate battery is often replaced by a zinc wire wrapped around the articles. The points of contact of the two metals are black or grey, but the stain disappears by plunging the object into the liquor for a few moments, after it has been separated from the zinc, and carefully scratch-brushed. Instead of separate batteries, a simple apparatus may be made of a glass, porcelain, or stoneware vessel holding the bath, and in the centre of which is a porous jar filled with a solution of 10 per cent. of cyanide of potassium or common salt. The

cylinder of zinc, immersed in this porous jar, carries a larger circle of brass wire, the cross diameters of which are soldered to the zinc. This brass ring projects over the bath, and the articles, suspended to the ring by slinging wires, hang down into the bath. At the beginning, the operation goes on rapidly, and the deposit is good; but, after a time, the solution of zinc traverses the porous cell and impairs the purity of the bath. An impoverished hot bath is reinvigorated by additions of equal parts of cyanide of potassium and silver salt. It is necessary to replace the water in proportion as it is evaporated. When the silver baths rapidly deposit metal without the aid of electricity, it is a proof that they are too rich in cyanide, or too poor in silver. A deposit effected under such conditions is rarely adhering, especially when upon articles previously coppered, because the excess of cyanide dissolves the deposited copper, and the silver which takes its place may be removed with the finger. The remedy consists in adding to the bath only enough silver salt and no more, so that a piece of copper will not become sensibly silvered in it, without the aid of electricity. The cold electro-silvering baths generally employed for electroplating such articles as table-spoons or forks are contained in large rectangular wooden troughs lined with gutta-percha, or made of riveted wrought iron. They are sufficiently high to allow about 4 inches of liquid above the immersed object, whose distance from the bottom and sides should be nearly the same, to give a regular deposit of metal at both extremities of the object. The upper ledge of the trough carries two brass rods all round, which do not touch one another, one above the other, so that other metallic rods, being put across, will rest upon the higher or the lower rod, but not both at the same time. Each rod is connected with one of the poles of the battery by conducting wires, the points of contact of which should be perfectly clean. The rod which supports the articles to be silvered is connected with the negative pole represented by zinc in most batteries; and the other, supporting the anodes, is attached to the positive pole, which is carbon with Bunsen's elements, copper for Daniell's, and platinum with Grove's cells. A certain number of spoons and forks fixed to a rod, by means of copper wires, are cleansed at the same time, and the rod is placed upon the negative conducting rod of the trough. Then, facing these articles, hang upon the positive conducting wire of the trough another metallic rod to which the soluble silver anode is attached like a flag. Next comes another series of spoons and forks, faced by another soluble anode, in such a manner that each row of spoons and forks is between two anodes. The articles to be silvered all rest upon the negative conducting rod, and the soluble anodes upon the positive one. This disposition is for obtaining an equal deposit upon all the pieces. The objects require turning upside down during the operation, in order to prevent a thicker deposit on the lower parts, as the richest part of the solution is the densest, and therefore lies near the bottom of the trough. The denser layers, being richer in metal, deposit it more abundantly upon the direction which they follow, and form grooves which cannot be filled by the lighter and poorer currents. It is, therefore, advantageous to keep the objects in constant motion. In this case the frame supporting the articles does not rest upon the trough, but is suspended above the bath, and receives its motion from a small eccentric, or other motive power. The silver deposit will adhere strongly, if the articles have been fully amalgamated in the solution of nitrate of binoxide of mercury, and have remained in the silver bath from 12 to 15 hours, according to the intensity of the current. The silvering will be the better and finer as the intensity of the current is weaker, up to a certain limit. A sufficient quantity of silver may be deposited in 3 or 4 hours, but the result is not satisfactory, and the burnishing is very difficult. When the articles have acquired a film of silver, they are sometimes removed from the bath and thoroughly scratch-brushed, cleansed in

alcohol, or, preferably, in a hot silvering bath, thence again passed through the mercurial solution, and finished in the former cold electro-bath. This first scratch-brushing, which is not always necessary, obviates the tendency of certain alloys to assume a crystalline appearance, and corrects imperfections of the cleansing process. Electro-silvering baths do not generally work so well when freshly prepared, as when they have been used for a certain time; the deposit is often granulated, bluish, or yellowish. It is therefore desirable to mix a portion of old liquors with those recently prepared, or new baths may acquire an artificial age by boiling them for a few hours, or adding to them one or two thousandths of aqua ammonia.

To prevent Electro-silver Plating turning Yellow by Contact with the Air.—This change of colour is due to the deposit, by galvanic action, of pure silver and of a subsalt, the subcyanide of silver, which is rapidly decomposed and darkened by light. It is therefore necessary to remove the subcyanide by one of the following methods;—1. The articles are left immersed in the bath for some time after the electric current has been interrupted, when the subcyanide of silver is dissolved by the cyanide of potassium. 2. Having smeared the objects with a paste of borax, they are heated in a muffle until the salt fuses and dissolves the subcyanide. This process anneals and softens the metal. 3. The poles of the battery are inverted for a few seconds, that is to say, the articles become soluble anodes, and the electric current carries away the subcyanide of silver in preference to the metal; this operation should be very short, otherwise the silver will entirely abandon the objects and will coat the silver sheets.

Silver-plating Britannia Metal, Pewter, and all Combinations of Lead and Tin.—These are best placed in a solution containing a good deal of free cyanide, and the deposit should be rapid at first. The surface of the anode should be about three times that required for German silver and the battery power strong, but not too intense. It is better not to disturb these articles in the solution at the beginning of the deposit. Afterwards they may be shifted for obtaining a uniform coat. If the articles, when they have been a short time in the plating bath, present an unequal surface, remove them, and brush over again as before; then, after well rinsing, return quickly to the bath and allow them, if possible, to remain without further disturbance.

Small Silver Bath for Amateurs.—The bath is a cylindrical stoneware, glass, or porcelain vessel. After cleansing and amalgamation, the articles are attached by clean copper wires to the circumference of a brass ring, supported upon the top of the apparatus by three or four soldered cross wires. The ring is connected with the negative pole of the battery, and the positive pole with a platinum anode, or a cylinder formed of a sheet of silver rolled round, which dips into the middle of the apparatus. The articles must be now and then turned upside down, and sideways, so that each face of the object will be, in turn, directly opposite the silver anode, and thus also the points of contact with the suspending wires receive their quota of metallic deposit. Points, edges, corners, and all raised parts, offer a more easy passage to the electric current, and therefore become more coated with metal. As the wear of tablespoons and forks is greater on their convex sides, those parts should face the silver anode longer than the concave portions.

Bright Lustre.—Bisulphide of carbon, in small proportion, imparts a bright lustre to electroplated articles. Put an ounce of bisulphide of carbon into a pint bottle containing a strong silver solution with cyanide in excess. The bottle should be repeatedly shaken, and the mixture is ready for use in a few days. A few drops of this solution may be poured into the plating bath occasionally, until the work appears sufficiently bright. The bisulphide solution, however, must be added with care, for an excess is apt to spoil the solution. In plating surfaces which cannot easily be scratch-brushed, this brightening pro-

cess is very serviceable. Care must be taken never to add too much at a time.

Deposits on Solder.—The difficulty of obtaining regular deposits of gold or silver over articles which have parts soldered may be greatly obviated by scratch-brushing those parts dry, that is, without the usual liquid employed. This renders these refractory parts better conducting, provided that during the operation no impurities are left on these spots.

Method by which the Weight of Deposited Silver is directly ascertained.—1. The articles are cleansed by the processes already described, then dried in saw-dust or otherwise, and weighed in a scale. However rapidly this may be done the surface of the copper will be slightly oxidized and tarnished; to recover their former cleanliness the articles must be plunged into a strong pickle of sulphuric acid, and then into the mercurial solution. After rinsing, and immersion in the bath, practical experience will teach when it is nearly time to withdraw the articles from the solution. They will have to be weighed several times before the intended weight of silver has been deposited. 2. Cleanse the articles, and put them immediately into the bath, except one, which is treated as above, and used as a test. This piece is now and then removed from the bath to ascertain its increase of weight, and when it has acquired its proportion of silver it is supposed that the other pieces are also finished. Strongly amalgamated articles will not become sensibly oxidized during the drying which precedes their weighing. When the objects have been dried in order to ascertain the proportion of deposited silver, they should not be returned to the bath without having been cleaned in a hot solution of cyanide of potassium, which dissolves the grease from the handling, and passed again through the solution of nitrate of binoxide of mercury, and rinsed. Alcohol may be substituted for the hot solution of cyanide, but the results are not so sure, and the expense is greater. Both these methods are tedious, and only give approximate results. 3. Remove one dish of an ordinary pair of scales, substitute for it a metallic frame which supports the articles to be silvered, and communicates through the beam and the column with the negative electrode of a battery; connect the soluble anode with the positive pole. When the articles are suspended to the frame, and are in the bath, the equilibrium of the scale is established by weights upon the other dish; add to this a weight equal to the silver it is desired to deposit. The operation will be finished when the equilibrium of the beam is re-established. This method is not mathematically accurate, but is sufficiently exact for all practical purposes. An automatic arrangement, by which the electric current may be broken at the time the articles in the bath have received a sufficient deposit of silver, is easily arranged, and saves time and metal.

Anodes.—Should the anodes become black during the passage of the electric current, the solution contains too little cyanide of potassium and too much silver. In this case the deposit is adherent, but too slow, and the bath loses more silver than it can gain from the anodes. Carefully add sufficient cyanide of potassium. If the anodes remain white during the current, the proportion of cyanide of potassium is too great, the deposited silver is often without adherence, and the anodes lose more metal than is deposited; add silver salt until it dissolves with difficulty. When in good working order the soluble anodes become grey during the passage of the electricity, and white when the circuit is broken. The specific gravity of the bath may vary from 5° to 15° of the Baumé hydrometer for salts, and still furnish good results. There is a simple and rapid process for ascertaining the state of the bath, and establishing the proper ratio between the silver and the cyanide. About half a pint of the liquor is put into a tall glass, and a solution of $\frac{1}{3}$ of an ounce of nitrate of silver in 3 oz. of distilled water is poured into the former, drop by drop.

If the white precipitate produced is rapidly dissolved by stirring, the liquor is too rich in cyanide, or too poor in silver; should the precipitate remain undissolved after long stirring, the liquor is too rich in silver and too poor in cyanide of potassium. When the precipitate is dissolved but slowly, the liquor is in the best condition.

Burnishing. — By burnishing, the roughness of an object is flattened down until the surface is smooth and polished, like a looking-glass. Burnishing is an important operation for electro-deposits which consist of a multitude of small crystals with intervals between them, and with facets reflecting the light in every direction. The deposited metal is hardened, and forced into the pores of the underlying metal, and the durability is thus increased to such an extent, that with the same amount of silver a burnished article will last twice as long as one which has not been so treated. The instruments employed for burnishing are made of different materials, and must be of great hardness and a perfect polish. Such are hardened cast steel, agate, flint, and blood-stone. For metallic electro-deposits steel and blood-stones are especially employed. There are several qualities of blood-stone; its grain should be close, hard, and without seams or veins; it should leave no white lines on the burnished parts, nor take off any metal, and its colour should be of an intense black-red. The steel must be fine and close grained, and perfectly polished. Should the polish of any burnishing tool alter by use, it is restored by friction upon a skin or leather attached to a wooden block, which is fixed to the bench. The leather is covered with polishing rouge in impalpable powder, or, preferably, with pure alumina obtained by calcining ammonia alum in a forge fire. Venetian tripoli, rottenstone, tin putty, emery, or many other hard substances finely powdered may be employed. The burnishing tools are of various shapes, such as a lance, a tooth, a knife, a half-sphere, or a dog's tongue, and a considerable stock is necessary. The burnishing is divided into two distinct operations; the first consists in roughing, and the second in finishing. The tools for the first have a sharp edge, whilst for the second operation they have a rounded surface. The tools for the hand or the lathe are fixed by copper ferules into short round wooden handles, so that the hand is not influenced by their weight; the tools for the arm or the vice are fastened to wooden handles sufficiently long to rest their slender part upon the arm or the shoulder, the stouter lower portion is grasped by the hand. The burnishing tools and the objects must be frequently wetted by certain solutions, some of which facilitate the sliding of the instrument, or with others which have a chemical action upon the shade of the burnished articles. Of the first are pure water, solutions of soap, decoctions of linseed, and infusions of the roots of marsh-mallow or liquorice; the second includes wine-lees, cream tartar, vinegar, alum in water. When burnishing gold applied upon electro-deposits of copper, as in gilding with a dead lustre by that method, use pure water for fear of producing a disagreeable red shade. A solution of green soap is sometimes preferred by operators, although when old it imparts an unpleasant tinge, owing to the sulphides of the liquor. When the burnishing is completed, the surface is wiped longitudinally with a soft and old calico rag. The polish obtained by burnishing is called black, when it reflects the rays like a mirror; and should the presence of mercury or a bad deposit prevent the tool from producing a bright surface, the object is said to be greasy. Articles which have been previously polished, and which generally receive a very trifling deposit, are not burnished, but rubbed with chamois leather and the best quality polishing-rouge. Too thick or too rapid electro-deposits cannot be burnished, but must be polished by rubbing with a leather and a mixture of oil and powdered pumice-stone, tripoli, or tin putty. Coarse powders are used at the beginning, and impalpable ones at the end of the operation. Polished silver deposits

are more agreeable to the eye than burnished ones; but the hardening of the latter renders them more durable.

To Dissolve Silver from Silvered Articles.—Cold Bath.—For dissolving silver in the cold the objects are hung in a large vessel filled with the following mixture;—Sulphuric acid at 66° Baumé, 10 parts; nitric acid at 40° Baumé, 1, in which they remain for a greater or less length of time, according to the thickness of the coat of silver to be dissolved. This liquid, when it does not contain water, dissolves the silver without sensibly corroding copper and its alloys; therefore avoid introducing wet articles into it, and keep the liquid perfectly covered when not in use. As far as practicable place the articles in the liquid so as not to touch each other, and in a vertical position, so that the silver salt will fall to the bottom. In proportion as the action of the liquor diminishes, pour in small and gradual additions of nitric acid. Dissolving silver in the cold is regular and certain, but slow, especially when the proportion of silver is great. The other more rapid process is then resorted to.

Hot Bath.—Nearly fill a flat pan of enamelled cast iron with concentrated sulphuric acid, and heat to a temperature of from 300° to 400° Fahr.; at the moment of using it, pinches of dry powdered saltpetre are thrown into it; then hold the article with copper tongs in the liquid. The silver rapidly dissolves, and the copper or its alloys are not sensibly corroded. According to the rapidity of the solution more or fewer pinches of saltpetre are added. All the silver has been dissolved when, after rinsing in water and dipping the articles into the cleansing acids, they present no brown or black spots, that is, when they appear like new metals. These two methods are not suitable for removing the silver from wrought and cast iron, zinc, or lead; it is preferable to invert the electric current in a cyanide bath, or to use mechanical processes. Old desilvering liquors become green after use; to recover the silver they are diluted with 4 or 5 times their volume of water, then add hydrochloric acid or common salt. The precipitation is complete when the settled liquor does not become turbid by a new addition of common salt or hydrochloric acid. The resulting chloride of silver is separated from the liquid either by decantation or filtration, and is afterwards reduced to the metallic state by one of the methods which will be described.

Resists and Reserves.—By reserves, certain parts of a metallic article, which may be already covered with an electro-deposit on its whole surface, are coated with another metal. To gild the parts in relief of an object of which the body is silvered, make a gold reserve, and use a silver reserve for silvering of certain parts of a body already gilt. This requires a little practice and care, and a firm hand to make thin lines with the hair pencil. Thoroughly scratch-brush and wipe the object; the parts intended to have the primitive colour must be covered by a brush with a resist varnish; dry in the air, or in a stove, or upon a gentle fire until it no longer feels sticky. Place in the bath; the galvanic deposit will only coat those parts unprotected by the varnish. The temperature of the bath should be low, and the current weak, for fear of having rough lines where the deposit touches the varnish, from the latter becoming softened, or from bubbles which are disengaged at the negative pole under the action of a strong electric current. When the deposit is completed, remove the resist varnish with warm essence of turpentine, and afterwards with tepid alcohol; gaseine or benzole are preferable, as they rapidly dissolve in the cold nearly all resinous and fatty bodies, or the varnish may be destroyed by a brief immersion in concentrated sulphuric acid when cold. It often happens that several colours and metals have to be placed upon the same object, such as silver with both a bright and a dead lustre, and yellow, green, red, white, or pink golds, or platinum. Varnishes are also employed for avoiding the deposit of the precious metals upon those parts which do not need them.

Resist or Reserve Varnishes.—Dissolve in boiled linseed oil or essence of turpentine, resin, or copal; these varnishes are not sufficiently coloured to distinguish the places where they have been laid on, mix with them therefore a certain proportion of red-lead, chrome yellow, or Prussian blue, which at the same time facilitates their drying.

OLD SILVERING.—To imitate old artistic productions made of solid silver, the groundwork and hollow portions not subject to friction are covered with a blackish red earthy coat, the parts in relief remain with a bright lead lustre. Mix a thin paste of finely-powdered plumbago with essence of turpentine, to which a small proportion of red ochre may be added to imitate the copper tinge of certain old silverware; smear this all over the articles. After drying, gently rub with a soft brush, and the reliefs are set off by cleaning with a rag dipped in spirits of wine. Old silver is easily removed, and the brightness of the metal restored, by a hot solution of caustic potash, cyanide of potassium, or benzole. To give the old silver tinge to small articles, such as buttons and rings, throw them into the above paste, rub in a bag with a large quantity of dry fir-wood saw-dust until the desired shade is obtained.

OXIDIZED SILVER.—This is not an oxidization, but a combination with sulphur or chlorine. Sulphur, soluble sulphides, and hydrosulphuric acid blacken silver, and insoluble silver salts, and particularly the chloride of silver, rapidly blackens by solar light. Add four or five thousandths of hydrosulphate of ammonia, or of quintisulphide of potassium, to ordinary water at a temperature of 160° to 180° Fahr. When the articles are dipped into this solution an iridescent coating of silver sulphide covers them, which after a few seconds more in the liquid turns blue-black. Remove, rinse, scratch-brush, and burnish when desired. Use the solution when freshly prepared, or the prolonged heat will precipitate too much sulphur, and the deposit will be wanting in adherence; besides the oxidization obtained in freshly-prepared liquors is always brighter and blacker than that produced in old solutions, which is dull and grey. If the coat of silver is too thin, and the liquor too strong, the alkaline sulphide dissolves the silver, and the underlying metal appears. In this case cleanse and silver again, and use a weaker blackening solution. Oxidized parts and gilding may be put upon the same article by the following method. After the whole surface has been gilt, certain portions are covered with the resist varnish, silver the remainder. Should the process of silvering by paste and cold rubbing be employed, the gilding should be very pale, because it is not preserved, and is deeply reddened by the sulphur liquor. When this inconvenience occurs from a too concentrated liquor, it is partly remedied by rapidly washing the article in a tepid solution of cyanide of potassium. Deep black is thus obtained upon cleansed copper;—Dissolve 3 or 4 oz. of blue ashes, hydrocarbonate of copper, in a sufficient quantity of aqua ammonia, place the cleansed copper in this solution, cold or tepid, it will be instantaneously covered with a fine black deposit. This coat is so thin that burnished articles look like varnished black.

NIELLED SILVER.—This is a kind of inlaid enamel work, and is obtained by the sulphuration of certain parts of a silver object. But instead of being direct, this is produced by inlaying the silver surface with a sulphide of the same metal prepared beforehand. For preparing the niel, heat a certain proportion of sulphur in a deep crucible; heat a certain quantity of silver, copper, and lead in another crucible, and when melted pour into the fused sulphur, which transforms these metals into sulphides; then add a little sal ammoniac, remove from the crucible, pulverize for use. First crucible—flowers of sulphur, 27 oz.; sal ammoniac, 2¾ oz. Second crucible, which after fusion is poured into the first—silver, ½ oz.; copper, 1½ oz.; lead, 2¾ oz. 1. After having reduced the niel to a fine powder, mix with a small proportion of a solution of

sal ammoniac, hollow out the engraving upon a silver surface, and cover the whole, hollows and reliefs, with the composition. The article is then to be heated in a muffle until the composition solders to the metal. Uncover the pattern by a level polish, when the silver will appear as over a black ground. This method is costly, as each article must be engraved. 2. Engrave in relief a steel plate, and press it against the silver plate between two hard bodies. The copy is hollow, and ready to receive the niel. A great many copies may be obtained from the same matrix.

PLATINUM DEPOSITS *by Dipping.*—Copper and its alloys only will receive a satisfactory platinum deposit; iron, zinc, lead, or tin, coated with this metal, even after a previous coppering, give but defective results. The platinum deposits are obtained by dipping thoroughly cleansed copper articles in the following solution, kept boiling;—Distilled water, 100 parts by weight; caustic soda, 12 parts; platinum for neutral chloride, 1. The deposit is bright, durable, and of a dark colour, resembling oxidized silver.

Thin Platinum Electro-deposits.—The platinum baths for electro-deposits will succeed when the chloride of platinum is dissolved in a solution of a salt with alkaline, neutral, or acid reaction, but sulphites and cyanides, even those having soda for base, should be excepted. Distilled water, 100 parts by weight; carbonate of soda, 40 parts; platinum for neutral chloride, 1. Temperature of the bath, from 160° to 180° Fahr. Distilled water, 100 parts by weight; phosphate or borate of soda, 60 parts; platinum for neutral chloride, 1. Distilled water, 100 parts by weight; pyrophosphate of soda, or chloride or iodide of sodium, 30 parts; platinum for dry chloride, 1. These baths only give exceedingly thin deposits; if the coating were allowed to increase most of it would be without adherence, and often in the form of scales. The deposit is black or steel grey.

Thick Platinum Electro-deposits.—Fill a glass flask with $\frac{1}{3}$ of an ounce of finely-laminated spongy or black platinum, and a mixture of $5\frac{1}{3}$ oz. of hydrochloric acid, and $3\frac{1}{2}$ oz. of nitric acid at 40° Baumé. Place the flask upon a piece of sheet iron perforated in the centre, so that the bottom of the flask alone receives the heat. After an abundant production of orange-yellow fumes, the platinum will disappear and leave a red liquid, which should be heated until it becomes viscous enough to stick against the sides of the flask. This latter part of the operation may be effected in a porcelain dish, the shallow form of which aids in the evaporation of the acids in excess. After cooling, the residuum is dissolved in $17\frac{1}{2}$ oz. of distilled water, and filtered if necessary. Dissolve $3\frac{1}{2}$ oz. of phosphate of ammonia in $17\frac{1}{2}$ oz. of distilled water, and mix the two solutions. This produces a precipitate of phosphate of ammonia and platinum in a liquid of orange colour, which should not be separated; pour into it, stirring all the while, another solution of $17\frac{1}{2}$ oz. of phosphate of soda in $1\frac{3}{4}$ pint of distilled water. Boil the mixture, and replace the evaporated water, until no more ammonia is disengaged, which is ascertained by the smell; and until the liquor, which was previously alkaline, begins to redden blue litmus paper. When the yellow liquor becomes colourless, it indicates the formation of a double platinum salt. The bath is then ready to deposit platinum upon articles of copper or its alloys, by the aid of heat and of an intense electric current. Copper coated with platinum resists nitric and sulphuric acids to a considerable extent. If iron, zinc, lead, or tin come in contact with the bath they will decompose it, and the metal deposited will be black. The dead lustre of platinum is pearl-grey; it is very hard, and cannot be brightened by scratch-brushes of brass, which render its surface yellow; powdered pumice-stone or iron wires should be employed. Platinum deposits may be burnished by an energetic friction, and the lustre obtained is very durable. Platinum may be removed from copper by a very long immersion

in the liquors given for ungilding, but the success is doubtful.

NICKEL DEPOSITS.—Nickel deposited by the wet way is white, with a slightly yellow tinge, having a dull pearl-grey dead lustre; it is obtained by dissolving the nitrate of nickel in its own weight of ammonia, and diluting the whole with 20 or 30 times its volume of liquid bisulphite of soda, marking about 24° Baumé. This application is found useful when articles require to be protected against the oxidizing action of damp or salt air, sulphurous gases, and weak acids. Nickel electrotypes stand the wear and tear caused by ink, and press much better than the ordinary copper ones. Another bath is a solution of nitrate of nickel, without excess of acid, precipitated by cyanide of potassium, and the precipitate redissolved by more cyanide. An acid solution of nickel may be precipitated by alkalies, such as potash, soda, or ammonia; after washing the precipitate, dissolve in cyanide of potassium. A moderate battery power and nickel anodes are employed.

Nickel Plating without a Battery.—Into the plating vessel, which may be of porcelain or copper, place a concentrated solution of zinc chloride, dilute it with from 1 to 2 volumes of water, and heat to boiling. If any precipitate separates, it is to be redissolved by adding a few drops of hydrochloric acid. As much powdered zinc as can be taken on the point of a knife is thrown in, which covers the vessel internally with a coating of zinc. The nickel salt, for which purpose either the chloride or sulphate may be used, is added until the liquid is distinctly green; then put in the articles to be plated, previously thoroughly cleaned, together with some zinc fragments. Continue the boiling for fifteen minutes, when the coating of nickel is completed. Well wash the articles with water, and clean with chalk. If a thicker coating is desired, the operation may be repeated. Wrought and cast iron, steel, copper, brass, zinc, and lead have been successfully coated by this process. It is necessary that the objects should be entirely covered by the plating liquid, and that their surfaces should be thoroughly cleaned. Salts of cobalt, treated in the same manner, afford a cobalt plating, which is steel grey in colour, not so lustrous as the nickel, and more liable to tarnish.

ZINC DEPOSITS.—Zinc is deposited by the wet way and by the battery. The dead lustre colour is a grey bluish-white. Precipitate a soluble zinc salt by ammonia; this precipitate redissolved in an excess of alkali gives a satisfactory bath; any kind of zinc salt may also be dissolved in cyanide of potassium or a soluble sulphite. These deposits are entirely different as regards the durability, from the so-called galvanizing, when cleansed iron is plunged into a bath of molten zinc, and is thus protected against oxidization for a long time, which is not the case with electro-deposited zinc. For depositing upon copper or brass, in the wet way, prepare finely-divided zinc, by pouring the molten metal into a previously strongly heated iron mortar, and stirring until nearly cold. The powdered zinc thus obtained is placed in a porcelain vessel, and to it is added a concentrated solution of sal ammoniac. This mixture is heated to boiling; and the copper or brass objects to be coated with zinc, but previously well cleansed, even with an acid, are then placed in a liquid where they obtain a brilliantly white adhering layer of zinc.

IRON AND STEEL DEPOSITS.—Iron may be deposited by the wet way, but is very easily oxidized. It is obtained by decomposing by the battery a perfectly neutral protochloride of iron. This bath is rapidly altered by the air, and is transformed into sesquichloride, which is unsuited for the purpose. The double chloride of iron and ammonium, obtained by the protracted boiling of a solution of sal ammoniac upon iron filings, produces a very thin deposit of iron, very difficult to oxidize, which is employed for hardening the surface of engraved plates or of ordinary electrotypes. Double sulphates of iron and ammonia, or of iron and potash, and double chlorides of the same bases, have been

successfully used for electro-deposits of iron.

ANTIMONY DEPOSITS.—This has all the brightness of polished cast iron. Its dead lustre is a slate grey, and it may be easily scratch-brushed and polished; it resembles black platinum, and may take its place in many cases. Boil for an hour, in a porcelain dish or enamelled cast-iron vessel;—Water, $2\frac{1}{5}$ galls.; carbonate of soda, 70 oz.; finely-powdered sulphide of antimony, $17\frac{1}{2}$ oz. Filter the boiling solution through paper or fine cloth; by cooling it deposits a reddish-yellow powder of oxysulphide of antimony. Boil this powder again in the same liquor, and the new solution is the antimony bath. It is necessary to use the bath constantly boiling. For the anode, use either a plate of antimony or a platinum wire.

LEAD DEPOSITS are obtained by the plumbite of potash or soda, which is prepared by the protracted boiling of $\frac{1}{3}$ of an ounce of protoxide of lead in $3\frac{1}{2}$ oz. of caustic potash or soda, dissolved in $2\frac{1}{5}$ galls. of distilled water.

Coloured Electro-Chromic Rings.—After the plumbite of soda bath has cooled off, the metallic or metallized article, connected with the positive pole, is dipped into it. Then the platinum wire, communicating with the negative pole, is gradually introduced into the liquor without touching the article, which is immediately coloured in various shades; too much intensity in the current will hide all the various tinges under a uniform dark brown coat. When an article is unsatisfactory in its colouration, dip it rapidly into aquafortis, to dissolve the oxide of lead, and restore the metallic surface to its primitive state. This process may be used for the decoration of stoneware and porcelain previously coated with platinum.

REDUCTION OF OLD BATHS.—*Extraction of Gold.*—All the liquids which contain gold, except those in which there is a cyanide, are strongly acidulated by sulphuric or hydrochloric acids, unless they are already acid, and then largely diluted with water. Precipitate the precious metal by a solution of sulphate of protoxide of iron, copperas, and, after a few hours standing, it is ascertained that the liquor does not contain any more gold when a new addition of sulphate of iron does not produce any turbidity. The precipitated gold is in the form of a red or black powder; collect upon a filter, wash, and dry in an iron pan, with weights equal to its own, of borax, saltpetre, and carbonate of potash. Gradually introduce the powder into a refractory crucible heated to a white heat in a good air-furnace. When all is introduced, increase the heat and close the furnace, so that all the metal may fall to the bottom of the crucible. After cooling, extract the button of pure gold which remains. If it is desired to dissolve the powdered gold left on the filter in aqua regia, it will be necessary to wash it several times with diluted sulphuric acid, to remove the sulphate of iron with which it is impregnated. This mode of reduction is adapted to an impure chloride of gold, to the baths by dipping with the bicarbonate or pyrophosphate of soda, and also to the ungilding acids; but it is imperfect with baths holding a cyanide, which never completely part with all the gold they contain, by this process. The best manner of treating the latter liquors is to evaporate them to dryness in a cast-iron kettle, and calcine the residue to a white heat in a good crucible. A small proportion of borax or saltpetre may be added to aid the fusion, but generally it is unnecessary. The resulting button of gold at the bottom of the crucible is red when saltpetre has been employed, and green with borax; but these differences of colour have nothing to do with the purity of the metal. Gold may be separated from liquors which contain no cyanide, by an excess of protochloride of tin, which produces a precipitate easily reduced by heat. Sulphurous acid will also reduce the gold; but in this case, the liquor should be heated. Granulated gold is obtained by running the molten metal, in a small stream, and from a certain height, into a large quantity of cold water.

Extraction of Silver.—Liquors contain-

ing silver in the form of a simple salt, in solution by an acid, are easily treated; add to them an excess of common salt, or hydrochloric acid, the silver will be precipitated as chloride of silver, which, after washing, may be employed for the preparation of new baths, or reduced to the metallic form. Solutions of nitrate of silver, or desilverizing acids, belong to this class. Common salt, however, is without action upon the liquids which hold silver in the state of a double salt, and will rather aid the solution than the precipitation; such are the double tartrate of silver and potash, whitening bath, the double sulphite of soda and silver, and the bath for dipping. Before employing common salt, add sulphuric acid, which, displacing the other acids, restores the silver to the state of a simple salt, easily precipitated by common salt. Hydrochloric acid alone precipitates silver well from these solutions. Liquors containing silver, as cyanide, are also exceptions; to extract all the metal, use the process employed for similar combinations of gold, evaporate to dryness, and reduce the mass in a crucible, with an addition of carbonate of soda and powdered charcoal. The metallic silver remains at the bottom of the crucible. To reduce chloride of silver—1. Put well-washed chloride of silver into an iron ladle, with a little pure water above the chloride. The greater affinity of iron for chlorine determines its departure from the silver; and, after standing 24 to 30 hours, throw the contents of the ladle upon a filter, and wash thoroughly with pure water, to remove the soluble chloride of iron; the residue will be pure silver in a minute state of division. This method is rarely employed on account of the length of time required. 2. Well-washed chloride of silver, water does not dissolve a trace of it, is put into a stoneware pan with two or three times its weight of zinc, and the whole is covered with water rendered acid by sulphuric acid. As soon as they are in contact, these substances react upon each other; the sulphuric acid and the zinc decompose the water, the oxygen of which oxidizes the zinc, which then combines with the acid, and forms sulphate of zinc, a very soluble salt; the hydrogen transforms the chlorine of the silver into hydrochloric acid, which is also very soluble in water. Before filtering, wait until all the zinc is dissolved. The remaining silver is in impalpable powder, and cannot pass through the filter. Wash the silver thoroughly with pure water, and it may then be dissolved in pure nitric acid to form a pure nitrate of silver. This process is seldom employed, as it is difficult to find zinc without lead, which will unite with and follow the silver in subsequent manipulations. 3. The chloride of silver, freed from foreign metallic salts by washing, is mixed with four times its own weight of crystallized carbonate of soda, and half of its weight of pulverized charcoal. Make into a homogeneous paste, dry thoroughly in an iron pan, and then place in a red-hot crucible. After fusion the heat is raised, in order to allow the smallest globules to reach the bottom of the crucible. Should the crucible be moved at the time of the solidification, the silver will be of a very irregular shape. To obtain granulated silver, pour it in a small stream, and from a height, into a large volume of water.

Extraction of Platinum.—1. Render any kind of platinum bath acid by hydrochloric acid, unless it is already so, and then plunge cleansed iron into it. The platinum is reduced to a black powder, wash, and calcine to a white heat. Dissolving it in aqua regia reconstitutes the chloride of platinum necessary for the preparation of the baths. 2. Reduce by evaporating the bath to dryness, strongly calcine the residue, then wash upon a filter to remove the soluble salts, and again heat to a white heat. The platinum thus obtained is soluble in aqua regia.

Extraction of Copper Salts.—Collect all the liquids holding copper in a large cask filled with wrought or cast iron scraps; a chemical reaction immediately takes place, the iron is substituted for

the copper to make a soluble salt, and copper falls to the bottom of the cask in the shape of a brown powder. The cask should be large enough to hold all the liquids employed in a day's work. The iron scrap should be suspended in willow baskets on the top of the liquor, and, by stirring now and then the liquid with them, the metallic powder of copper will alone fall to the bottom of the cask. The same method may be employed for recovering the copper from old cleansing acids, or from worn-out galvanoplastic baths. The copper thus obtained is quite pure; calcining it in contact with the air, gives a black binoxide of copper for neutralizing too acid galvanoplastic baths.

Ashes.—Sweepings, saw-dust, residues from the bottoms of scratch-brushing tubs, filters, papers, and rags, must be collected, mixed, and burned in a furnace constructed for the purpose. The ashes are finely pulverized, sifted, and thoroughly mixed with a quantity of mercury, which combines with the gold and silver. The amalgams, separated by washing, are then distilled in cast-iron retorts of a peculiar shape. The mercury volatilizes, and the gold and silver remain in the retort. For separating these metals, granulate the solid mass and treat with pure nitric acid, which dissolves the silver, and is without action upon the gold. The latter metal collects at the bottom of the vessel in a black or violet powder, and is pure, after having been washed in distilled water. If an ingot contains only a little silver and much gold, melt previously with a certain proportion of the former metal, in order to more easily dissolve in nitric acid. The ingots of silver and copper should be boiled in cast-iron kettles with concentrated sulphuric acid, which transforms the copper into soluble sulphate of copper, and silver into sulphate of silver, only slightly soluble. The separation of the two may be partly effected by washing, but, generally, the silver is precipitated by plates of copper. The alloy, previous to its solution, should be granulated.

Galvanoplasm. Thick Deposits.—Galvanoplasm consists of deposits with sufficient thickness to form a resisting body, which may be separated from the objects serving as moulds, and which will preserve the shape and dimensions of the model. A statue of plaster of Paris, wood sculpture, an impress in wax, fruit, and similar things, may, after certain preparations, be covered with electro-deposits, for instance, which will give a deposit representing the same shape and dimensions. In galvanoplastic operations copper is almost exclusively employed. It is possible to have the deposits entirely of silver and gold; but these are exceptions, on account of the cost of the materials and of the difficulties of the operation. The following is a summary of the usual requirements;—1. To apply upon a metallic surface conductor of electricity, a deposit of copper adhering to the metal underneath. 2. The above operation being completed, the two metals must be separated in such a manner that they will furnish two identical productions, one of which will be in relief, and the other hollow, for casts of medals, &c. 3. To apply the electro-deposits upon substances not naturally conductors of electricity, but rendered so by the process of metallization; upon ornaments of plaster of Paris, wax, glass, or porcelain, or upon leaves, fruits, and insects. 4. After the deposit to separate the non-metallic model to have a perfect copper copy of it. For reproduction of type in stearine, gutta-percha, gelatine. 5. Or, if it is impossible to apply the electro-deposit of copper directly upon the model, make moulds upon which a greater or less number of copies may be obtained. This is the general case;—The imprint of the model is taken with a plastic substance, which is rendered a conductor of electricity, and upon which the galvanoplastic deposit is effected.

The Baths.—1. Put into a vessel, made of glass, stoneware, porcelain, gutta-percha, or lead, a certain quantity of water, to which is added from 8 to 10 per cent. of sulphuric acid. If

in a glass vessel, or one lined with gutta-percha, pour in the acid slowly and stir all the time, otherwise the acid, which is much denser than water, falls to the bottom, and slowly combining with the surrounding water, may cause an increase of temperature sufficient to break the glass or melt the gutta-percha. 2. Dissolve in this liquor as much sulphate of copper as it will absorb at the ordinary temperature. Stir frequently with a glass or wooden rod, to mix the solution; or the sulphate of copper may be put into a perforated ladle of copper or stoneware, or into a bag of cloth, fixed near the surface of the liquid. When the liquid refuses to absorb any more crystals, it is saturated, and marks about 25° of Baumé's hydrometer. Baths of sulphate of copper, while they are working, must always be kept saturated; new sulphate of copper must be introduced to replace that decomposed and forming the metallic deposit; for this purpose suspend to the top of the vessel, and in the upper portion of the liquid, bags always filled with crystals of sulphate of copper. It is necessary to use good sulphate of copper; the best is in crystals, semi-transparent, and of a fine blue colour. Its solution is also a pure blue. These baths are always used cold, and are kept in vessels of shapes adapted to the wants of the operator. Stoneware, porcelain, and glass are the best materials for the purpose; but as it is difficult to find vessels sufficiently large, wooden troughs covered inside with coats of gutta-percha, marine glue, or with a sheet of lead, are used, painted with resist varnish.

Deposits by Separate Batteries.—After proper preliminary operations, the object which is to receive the deposit is connected with the conducting wire attached to the negative pole of the battery, zinc generally, and immersed in the solution; and the conducting wire starting from the positive pole, carbon or copper, is attached to a foil or plate of copper, and this anode is placed in the liquor parallel to the object connected with the other pole. This plate should have a surface at least equal to that of the article to be covered. The deposit will begin immediately, and its progress may be seen by removing the object from the solution. If upon a clean metallic substance, the deposit of copper will be instantaneous on every part of it; if, on the contrary, the surface only moderately conducts the electricity, as plumbago or graphite, the deposits will begin at the points touched by the conducting wire, and then proceed forward. With a little practice it is easy to ascertain whether the intensity of the current corresponds to the surfaces to be covered. The operation will be slow with a weak current, but there is no other inconvenience, unless the substance of the mould is alterable, like gelatine. Too intense a current results in a granular deposit, of which the particles have little cohesion between themselves, and no adherence to the mould.

Simple Apparatus for Amateurs.—Place the solution of sulphate of copper in a stoneware, earthenware, or porcelain vessel, in the centre of which stand a porous cell filled with water with 2 or 3 per cent. of sulphuric acid, and 1 per cent. of amalgamating salts. This liquid must surround an inner cylinder of zinc, upon the top of which rests a circle of brass wire, by two crossed bars soldered, or fixed in four notches on the top of the zinc cylinder. Suspend from this circular framework, projecting over the copper solution, a certain number of objects or moulds, immersed in the liquid in such a way as to have their faces to be covered near and opposite to the cell. Two small hair bags filled with sulphate of copper crystals, should be attached to the upper edge of the vessel.

Large Apparatus.—To cover large surfaces, use a bath contained in a large wooden trough, lined inside with gutta-percha, or lead, or other substance unacted upon by the bath. In the middle of the trough dispose a row of cells close to each other, and each with its zinc cylinder. Connect a thin metallic ribbon with all the binding screws of the cylinders, in contact at its extremities with two metallic bands on the ledges of the trough. The metallic rods to support the moulds are placed in contact with the metallic bands of the ledges, and there-

fore in connection with the zincs. If the objects are in high relief, use a circular trough, place the cells in a circle, and the mould to be covered in the centre. Whatever the shape of the mould, its position should now and then be changed, because the lower layers of the bath give more abundant deposits, owing to the difference of specific gravity of the layers more or less charged with sulphate. As far as practicable, maintain the liquids in the bath and in the cells at the same level; or it is better to have that of the bath slightly above that of the cell, to prevent the solution of zinc from mixing with the copper bath.

Porous Cells.—Pipeclay, pasteboard, bladder, gold-beater's skin, and parchment, sail-cloth, and certain kinds of wood may be employed, but nothing equals porcelain clay, submitted to a certain heat, which hardens the paste without destroying its porosity. Vases made with this material are just porous enough, and resist the action of concentrated acids.

Batteries.—The battery, charged as has been described, will work well for 24 hours; and, for four consecutive days, it will only be necessary to add small quantities of acid and amalgamating salt, in proportion to the volume of the cells. Stir the mixture each time with a glass rod. The fifth day, throw away all the exciting liquors, and substitute fresh ones, otherwise the zinc salt will be so abundant as to crystallize upon the zincs and the cells. A cell may be clogged in two ways,—by the sulphate of zinc which having an insufficiency of water, crystallizes in the pores. In this case boil the cells in water acidulated by sulphuric acid. Or by deposits of copper caused by bad working; dip the cells in aquafortis until all the copper is dissolved, and rinse in plenty of water afterwards. It is also possible to clean cells by keeping them filled with water, which, escaping through the pores, pushes out the salts and the acids with which they are clogged. Cast zinc will work, but is far inferior to laminated zinc, which will be uniformly corroded instead of being perforated. It sometimes happens that zinc is scarcely attacked, even by concentrated liquors, and that a multitude of small cavities are engraved on its surface. It also becomes covered with a blackish-grey crust, and no electricity is disengaged. These inconveniences occur when the zinc is too rich in lead.

Amalgamating Salt.—To avoid the solution of the zinc when the apparatus is not at work, cleanse it in diluted hydrochloric acid, and then amalgamate it by rolling the cylinders in a trough filled with mercury.

Acid Baths.—When a bath contains too weak a solution of sulphate of copper, the electro-deposit is pulverulent, black and irregular. The same inconvenience occurs when the liquors become too acid, because then they do not dissolve enough of sulphate of copper. When the bath is too acid, add carbonate of copper to it until effervescence no longer takes place. The bath should then be acidified anew to increase its conducting power. The carbonate of copper may be replaced by the oxide of the metal, which dissolves without effervescence. If, after very long use, a bath becomes overloaded with free acid and sulphate of zinc, there is no remedy but to start a fresh one.

Placing the Pieces in the Bath.—The depth of the bath should be sufficient to have a little liquor above and below the moulds. If the moulds are lighter than the solution of sulphate of copper sink them with lead pieces covered with varnish, with stones, or other non-conductors of electricity. When the object to be covered is metallic, and unacted upon by the solution of sulphate of copper, attach the conducting wire to any part of its surface, and it will be rapidly covered with a uniform deposit; if the mould is a non-conductor of electricity, and has been covered with some conducting substance, such as plumbago, bronze powder, or reduced silver, multiply the points of contact, as much as practicable, of the electrode, by uniting the connecting wire with a number of fine copper wires, and making their bent extremities touch the mould at various places. This method gives a greater rapidity of operation, and a uniform thickness of deposit. It is especially necessary for

moulds having deeply indented surfaces. As soon as the surface is entirely covered remove the supplementary wires. If only one face of the mould is to receive the deposit protect the other surfaces by a resist varnish, melted yellow wax, or softened gutta-percha.

Adhesive Deposits upon Metals.—Metals are unequally qualified to receive the galvanoplastic deposit; and some are naturally unfit for it. For instance, wrought and cast iron, steel, and zinc, as soon as immersed in the solution of sulphate of copper, and without the aid of electricity, decompose the salt, and are coated with a muddy precipitate of copper without adherence. It is necessary to give them previously a thick coat of copper in the bath of double salts before submitting them to the action of the sulphate of copper. Tin, although presenting these inconveniences in a much less degree, should also be copper electroplated in the solutions of double salts before going into the bath. When the metal to be covered is unacted upon by the bath, cleanse it well, and submit it to the action of the current, which will give a rapid and uniform deposit; this should not be too thick, otherwise the surfaces may have a coarse appearance, which impairs the fineness of the lines of the mould. With a good bath, and a well-regulated electric current, the delicacy of the pattern will not be defaced by a copper coat having the thickness of stout writing paper. A bright lustre may be obtained by scratch-brushing or burnishing; or by a passage through aquafortis and soot, and afterwards through the compound acids for a bright lustre.

Dead Lustre Gilding by Galvanoplastic Deposit.—Adhering galvanoplastic deposits give a very cheap and handsome gilding with a dead lustre, which, although not equal in durability, has the appearance of that obtained with mercury, already described. Having cleansed the mould if metallic, or rendered it a conductor if non-metallic, immerse it in the solution of sulphate of copper, and allow the deposit to acquire a dead lustre slightly in excess of that desired. After this operation, which may last from 2 to 6 hours, remove the article from the bath, rinse it in plenty of water, and pass it rapidly through the compound acids for a bright lustre, which diminish the previous dulness of the appearance. Next rinse in fresh water; steep in a mercurial solution similar to that employed for gilding by dipping; rinse again; and immerse in an electro-gilding bath made of;—Distilled water, $2\frac{1}{5}$ galls.; phosphate of soda, 21 oz.; bisulphite of soda, $3\frac{1}{2}$ oz.; cyanide of potassium, $\frac{2}{3}$ of an ounce; gold, for neutral chloride, $\frac{1}{3}$ of an ounce. At first, the current is rendered sufficiently intense by dipping the platinum anode in deeply; afterwards the intensity is diminished by partly withdrawing the anode until the entire shade of gold is obtained. This gilding requires but little gold, as the frosty dead lustre comes from the copper. When the lustre of the copper is very fine and velvety, dispense with the dipping into the compound acids, but the rapid passage through the mercurial solution is always desirable. If the deposited gold is not uniform, or appears cloudy, it is proof of an imperfect deposit in the bath, or of an insufficient steeping in the compound acids. The piece should then be removed from the bath, washed in a tepid solution of cyanide of potassium, rinsed in fresh water, dipped in the solution of nitrate of binoxide of mercury, and electro-gilded anew. This gilding bears burnishing well; avoid acid waters and soap, which will produce a red polish, and use only the fresh solutions of linseed, or of marsh-mallow root. The tone of gold thus obtained is richer, deeper, and more durable than that produced upon frosted silver, the latter being recognized by the green colour of the burnished parts. This kind of deposit may be employed for binding substances together, because the covering coat will be continuous.

Galvanoplastic Deposits without Adhesion.—After thoroughly cleaning the pattern, rub it with a brush charged with plumbago, or with a soft brush slightly greased by a tallow candle. The film of fatty substance should not be seen at all. The deposit obtained

represents an inverted image of the pattern, and the raised parts become hollow. Remove the mould, and perform the same operation upon the deposit, and this second deposit is the accurate reproduction of the first pattern.

DEPOSITS UPON NON-METALLIC SUBSTANCES.—By this process porcelain, crystal, plaster of Paris, wood, flowers, fruits, animals, and the most delicate insects may be coated. These substances have no conductive power for electricity; it is, therefore, necessary to metallize them.

Metallization.—This coat should be so thin as not to alter the shape or the minutest parts of the model.

Plumbago, or graphite, is generally preferred, and in most cases its conducting power is sufficient; and it may be applied in films thin enough not to impair the sharpness of the mould. The plumbago found in the trade is rarely pure. Remove the impurities by digesting for 24 hours a paste made of plumbago and water, with hydrochloric acid. Several washings with water, and slow drying in a stove, finish the operation. If the plumbago is in large lumps, it should be powdered and passed through a silk sieve. The conducting power of this substance is sufficient when the surfaces are not deeply indented; but the mould should be rough enough for the plumbago to stick to it.

Gilt Plumbago has a conducting power much greater than that of the ordinary substance. Prepare as follow;—In $1\frac{3}{4}$ pint of sulphuric ether dissolve $\frac{1}{3}$ of an ounce of chloride of gold, and thoroughly mingle with it from 18 to 20 oz. of good plumbago. Then pour into a shallow porcelain vessel, and expose to the action of air and light. After a few hours the ether completely volatilizes; stir the powder now and then with a glass spatula. Finish the drying in a stove.

Silvered Plumbago.—Dissolve 3 oz. of crystallized nitrate of silver in 3 pints of distilled water; mix this solution with 2 lbs. of good plumbago. Dry in a porcelain dish, and then calcine at a red heat in a covered crucible. After cooling, powder and sift. Plumbago thus metallized conducts electricity nearly as well as a metal, although it is very expensive. Bronze powder mixed with plumbago is also used.

Rendering Moulds Impervious to Liquids.—Porous substances, before being coated with plumbago, are submitted to a previous operation, to render them impervious, by covering them with a coat of varnish, or by saturating them with wax, tallow, or stearine. For instance, with a plaster cast, cut a groove on the rim of the mould, place in it a brass wire, twist the ends, which must be long enough to hold the cast by. The cast, having been previously dried, is then dipped into a bath of stearine kept at a temperature of from 180° to 212° Fahr., and a number of bubbles of air will escape from the mould to the surface. When the production of air-bubbles is considerably diminished, remove the cast from the bath. When the cast is tepid, cover it with powdered plumbago, and let it get quite cold. Then, after breathing upon it, rub thoroughly with a brush covered with plumbago; and be careful that the surfaces are completely black and bright, without grey or whitish spots. When the mould is very undercut, it is difficult to employ plumbago. In such cases metallize the whole, or the deep parts only, by the wet way. Soft brushes should not be used for rubbing plumbago. When the substances to be metallized are not porous, such as glass, porcelain, stoneware, horn, and ivory, cover them with a thin coat of varnish, which, when nearly dry, receives the plumbago.

Metallization of Ceramic Articles.—After having varnished the portions of the piece to be coppered, cover them with very finely laminated foils of lead, which bend to all desired shapes; then connect a brass conducting wire with the lead, and dip the whole into the bath; copper is immediately deposited upon the metallic parts. Thus glass vases may be entirely covered with copper, upon which deposit layers of gold or silver. The chaser may penetrate with his tool to different depths,

and uncover one after the other, first the layer of silver, next that of copper, and at last the crystal itself. The vase will appear as if set in a net of various colours. For very fine work, the gold ornament first painted with the pencil, and fixed in the usual manner by heating in a muffle, is put in contact with a very thin conducting wire, and the whole immersed in a copper, silver, or gold bath, where the deposit takes place in the same manner as upon an ordinary metal, and the adherence is as perfect as that of the film of gold upon the porcelain. The deposit is afterwards polished, chased, or ornamented on the lathe.

Metallization by the Wet Way.—Silver, gold, and platinum, reduced from their solutions, have an excellent conducting power. Silver is generally preferred, and its nitrate is dissolved in certain liquids, variable with the substances to be covered. Apply the solution with a pencil upon the mould, and let it dry; repeat the operation two or three times. Lastly, expose the mould to the action of the sunlight, or of hydrogen, or fix it to the top of a box which closes hermetically, and at the bottom of which is a porcelain dish holding a small quantity of a concentrated solution of phosphorus in bisulphide of carbon. After a few hours this solution completely evaporates, and reduces to the metallic state the nitrate of silver covering the mould, which becomes black, and is then ready for the bath. When used to metallize wood, porcelain, and other resisting substances, dissolve 1 part of nitrate of silver in 20 parts of distilled water. With fatty or resinous materials, which water will not wet, use aqua ammonia. With very delicate articles, which will not bear a long manipulation, make the solution in alcohol, which evaporates rapidly. Concentrated alcohol dissolves nitrate of silver but slightly; but enough will be dissolved for metallizing flowers, leaves, and similar articles, if the solution is aided by grinding in a mortar. If the conducting wire is fixed to the mould before the metallization, the wire must be of gold, silver, or platinum, as the other metals rapidly decompose the solution of nitrate of silver; but brass and copper wires may be employed when the metallization is completed, after the reduction by phosphorus.

Solution of Phosphorus in Bisulphide of Carbon.—Half fill a glass stoppered bottle with a large neck with bisulphide of carbon, then gradually introduce the phosphorus gently dried with blotting paper, and shake the bottle now and then. Phosphorus is added until no more dissolves. This preparation requires great care in the handling, because in drying upon combustible materials it takes fire spontaneously.

Plaster of Paris Moulds.—After the original model, say a medal, has been thoroughly rubbed with soap or plumbago, wrap round the rim a piece of stout paper, or thin lead foil, and bind it in such a manner that the article to be copied, face upwards, is at the bottom of the box thus formed. Then in a vessel filled with a sufficient quantity of water, sprinkle fine plaster of Paris until the last portions reach the level of the water. After waiting for one or two minutes, stir, and the thin resulting paste must be employed immediately. With a painter's brush give a thin coat of this paste, and press into all the recesses; this is to expel the air; then pour the remainder of the paste up to a proper height, and allow it to set. After a few minutes the plaster hardens, and may be separated from the paper. Scrape off what has run between the paper and the rim of the medal, and the plaster cast will separate from the model. Plaster of Paris moulds cannot be introduced into the bath without having been previously rendered impervious.

Moulding with Stearine and Wax.—Stearine is melted and poured upon the model when it is going to set. When stearine is too new or dry, it crystallizes in cooling, and this impairs the beauty of the cast. In such case it should be mixed with a few drops of olive oil, or with tallow, or suet; if it is made too fat, it will remain soft and difficult to separate from the mould. It should then be mixed with virgin wax or sper-

maceti. As stearine contracts considerably by cooling, its employment must be avoided when the copies are required to be perfectly accurate. When it is desired to make a cast with stearine of a plaster model, the latter should be thoroughly saturated with water or stearine beforehand, and should also be perfectly coated with plumbago before the melted substance is poured upon it, otherwise the two will stick together, and it will not be possible to separate the cast from the model. Wax may also be employed in the same manner, but its price and want of hardness interfere with its application.

Moulding with Fusible Metal.—This metal is a perfect conductor of electricity, and therefore well adapted to the production of homogeneous deposits of equal thickness; it is, however, seldom employed, on account of the difficulty of the operation, of its crystalline texture, and of the presence of air-bubbles. 1. Pure lead, 2 parts in weight; tin, 3; bismuth, 5; fusible at 212° Fahr. 2. Pure lead, 5 parts in weight; tin, 3; bismuth, 8; fusible from 180° to 190° Fahr. 3. Pure lead, 2 parts in weight; tin, 3; bismuth, 5; mercury, 1; fusible at 158° Fahr. 4. Pure lead, 5 parts in weight; tin, 3; bismuth, 5; mercury, 2; fusible at 125° Fahr. For those alloys without mercury, the component metals may be melted together; when mercury is employed, it should be added when the three other melted metals have been removed from the fire. To obtain a thorough mixture the alloy should be stirred with an iron rod, or melted over and cast several times. 1. Run the metal into a small dish, remove the oxide with a card, and then apply the model, give it a few taps when the setting takes place; or put the model into the dish, and pour the clean alloy upon it. 2. Put the medal at the bottom of a small box of iron or copper, and bury half of its thickness in plaster of Paris; then, cover the medal with the cold fusible alloy, and apply heat until it is melted, when it is allowed to cool off. It is easy to separate the medal from the fusible alloy, as the portion protected by the plaster of Paris may then be grasped. A well-made cast of fusible alloy is the best mould for galvanoplastic operations with silver and gold. Alloys containing mercury should not be used for taking casts from metallic medals, iron excepted, which would be amalgamated and injured. Copper deposits obtained upon such alloys are very brittle. Melted sulphur produces very neat and sharp casts; it is, however, very difficult to get it metallized, and it transforms the deposit of copper into sulphide.

Moulding with Gelatine.—In certain conditions, the elasticity of gelatine and gutta-percha allows of removing them from undercut or highly-wrought parts, and they reacquire the shape and position they had before the removal. This property is found in gelatine to a higher degree than in gutta-percha, but it requires a very rapid deposit, otherwise it will swell and be partly dissolved by too long an immersion in the solution of sulphate of copper. Put a sufficient quantity of colourless plates of gelatine in cold water, and let it swell there for about 24 hours; then drain off the water, and heat the gelatine upon a water bath until it has become of a syrupy consistency; it is then ready to be poured upon the object, which must be encased in a box of pasteboard or of thin lead. After cooling for about 12 hours, separate the cast from the object. To enable the gelatine to remain longer in the bath without alteration, use one of the following mixtures;—1. Dissolve the best gelatine in hot water, and add $\frac{1}{50}$th of the weight of gelatine in tannic acid and the same quantity of rock candy; then mix the whole thoroughly, and pour upon the model in its box. After a few hours the gelatine may be easily separated from the object. 2. A mould having been made with gelatine alone, pour on it a solution of water holding 10 per cent. of bichromate of potash, and after draining, expose the mould to the action of the sun. 3. Beat, in 2 pints of distilled water, the whites of 3 eggs, filter, and cover the entire surface of the gelatine mould with this liquid. After drying, operate with the

solution of bichromate of potash, as in No. 2. 4. Pour some varnish upon the gelatine mould, drain carefully, and let it dry. The best varnish for the purpose is a solution of india-rubber in benzole, or in bisulphide of carbon. The mould must be metallized, and, when in the bath, submitted to a galvanic current of great intensity at the beginning. When the entire surface is covered with the copper deposit, and swelling is no longer to be feared, the intensity may be reduced.

Moulding with Gutta-percha.—Gutta-percha is entirely insoluble in water, in weak acids, and in the solution of sulphate of copper. After purification in boiling water, plates of various thicknesses or lumps are formed. A quantity sufficient for the intended mould is cut and put in cold water, which is gradually heated, until it is soft enough to be kneaded with the fingers like dough. After having pulled the gutta-percha in every direction, the edges are turned in so as to form a kind of half ball, the convex and smooth surface of which is then applied upon the middle of the model. Then the gutta-percha is spread over and forced to penetrate the details of the object. The kneading is continued so long as the material remains sufficiently soft, when it is allowed to cool. As soon as it is lukewarm, the gutta-percha is separated from the model, and dipped into cold water, when it hardens, and may then be handled without danger of impairing its accuracy.

Moulding with the Press.—After the object has been carefully coated with plumbago or tallow, it is put square and firm upon the table of the press, and surrounded with a ring or frame of iron, which should be a little higher than the most raised parts of the object. A piece of gutta-percha at least double the thickness of the pattern, is cut so as to fill the ring or frame of iron, and then heated, on one of its faces only, before a bright fire. When about two-thirds of its thickness have been softened, it is to be placed, soft portion downwards, in the iron ring or frame, and the whole covered with a block of metal exactly fitting. The screw to the press is made to act slowly at first, but with gradually increased force, as the gutta-percha becomes harder and more resisting.

Moulding with a Counter-mould.—Cast a thick block of lead upon sand, hollow out approximately with a graver the places corresponding to the reliefs of the pattern, bearing in mind the desired thickness of the gutta-percha. Spread over the pattern a plate of gutta-percha of the same thickness all through, upon this place the lead block, compress by the screw press. This process produces excellent results.

Moulding in the Stove.—This is convenient for brittle articles of plaster of Paris, marble, or alabaster. The pattern is put upon a dish of iron or earthenware, a ball of gutta-percha is placed in the middle of the object to be moulded, and the whole is placed in a stove, where the temperature is just sufficient to melt the gutta-percha, which softens and penetrates all the details; when it has sunk completely, remove it from the stove, and allow to cool off until it still retains sufficient elasticity to be separated from the pattern.

Moulding by Hand.—The foregoing process does not suit objects which will not bear the heat of the stove; for such articles heat the gutta-percha slowly until it becomes a semi-fluid paste; pour a sufficient quantity of it upon the pattern previously placed in an iron frame or ring. After a few minutes, knead it, with wet or oiled fingers, to make it penetrate all the details of the pattern until it scarcely yields to the pressure. In removing the mould from the pattern, cut off all the useless parts of the gutta-percha, and especially those which may have passed under the pattern and bind it. Then the proper position and shape of the covered pattern must be ascertained, so as not to break the model, or tear the gutta-percha. In moulding with the press, gutta-percha of the best quality is generally employed. For moulding by sinking or kneading, gutta-percha should be mixed with certain substances to increase its fusibility, such as linseed oil, lard, tallow, or yellow wax. Their proportions should never be over

one-third of the total weight. The mixture with linseed oil is made by heating in a kettle 1 part of linseed oil, and when its temperature has reached from 190° to 212° Fahr., add gradually, and stir in 2 parts of gutta-percha cut into small pieces. When the whole is in a pasty form, and begins to swell up with the production of thick fumes, remove the kettle from the fire, and throw its contents into a large volume of cold water, where, without loss of time, the paste must be well kneaded. While still hot, place it upon a slab of marble or stone; it may afterwards be rolled between middling warm rollers. Gutta-percha may be used for an indefinite length of time. Models of plaster of Paris, from which moulds of fusible metal or of gelatine are to be taken, will stand the operation much better if they have been hardened by being saturated with boiled linseed oil, to which a certain proportion of dryer has been added. They must be oiled again just before pouring the gelatine over them.

Deposits on Undercut Patterns which are Sacrificed.—A cast of a human head in plaster of Paris may be rendered impervious, and then metallized. After a deposit of copper has been effected on its surface, remove the plaster by boiling, and breaking it through the opening of the neck. The copper mould thus obtained, after being slightly greased inside, serves as a galvanoplastic trough, which is to be filled with the solution of sulphate of copper. Suspend bags filled with crystals of blue vitriol to the edges, and with a separate battery and soluble anode, or with a porous cell placed inside the mould, which is connected with the zinc, another deposit of copper takes place in the cavity. When the thickness of the metal is sufficient, strip off the mould or first deposit. This process is expensive, but gives sure results with large patterns having large raised parts. With small or narrow, or very crooked objects, moulds in several parts must be used, although the seams require mending.

Method for Articles in High Relief with Gutta-percha Moulds.—If it is required to imitate a statue, or other large article, commence by making with gutta-percha a mould in several pieces, which, by means of proper marks, may be united together, and form a perfect hollow mould of the pattern. Cover all these parts carefully with plumbago. Make a skeleton with platinum wires, to represent the outline of the pattern; this must be smaller than the mould, as it has to be suspended in it without any point of contact. The skeleton is to be enclosed in the metallized gutta-percha mould, and the whole immersed in the galvanoplastic bath; connect the inner surface of the mould with the negative pole of the battery, and the skeleton, which should have no point of contact with the metallized surface of the mould, of platinum wires with the positive pole; this decomposes the solution of sulphate of copper, which must be placed in the mould. When the deposit has reached the proper thickness, remove the gutta-percha mould, inside which will be found the statue, which may be finished at a very small expense. Lead wires may be substituted for the platinum, they are cheaper, and may easily be removed, when done with, by melting. But the execution of the process is not easy, as it is very difficult to ascertain that the skeleton anode is nowhere in contact with the enclosing mould; to avoid such contact, wrap all the external parts of the platinum anode with a spiral of india-rubber thread. As the increase of the deposit of copper reduces the distance between the mould and the anode, the latter and the deposit may come in contact, and stop the operation without any exterior sign to attract attention. Thus, if in a trough holding many moulds, one point of contact were established between the two poles, mould and skeleton, all the electricity of the battery would escape at that place, and the working of the bath would stop entirely. To obviate this inconvenience, support all the moulds of the same bath by hooks suspended to a metallic rod. These hooks must have no contact with the metallized surfaces of the moulds, which must be connected with the negative pole by

metallic wires terminated above the liquid by very fine iron wires. The connecting wires of the skeleton anode are to pass through the same opening as the negative electrodes, but without contact, and are united to the positive pole. So long as there is no contact between the skeleton and the interior of the mould, the electric fluid finds sufficient passage through the several fine iron wires which connect the moulds with the battery; but, if any contact takes place, the whole of the electricity rushes to that point, and, being too abundant for the small iron wire, it heats and burns it out rapidly. The work is thus instantaneously stopped for this mould, and continues for the others; and the broken wire shows where the defect is. The iron wire should be very short, so as to burn rapidly. In closed moulds and with an insoluble platinum anode, the solution of sulphate of copper will be rapidly transformed into sulphuric acid and water. Therefore make two holes at the lower part of the mould, through which and the opening at the head left for the passage of the electrode a free circulation of the liquor in the bath may take place. When the operation is completed, remove the gutta-percha mould, and the skeleton anode must be pulled out. Close the three holes in the statue, and file off the seams left at the junction of the different parts of the mould.

Filling the Hollow Deposit with Brass Solder.—First cover the exterior with clay, plaster of Paris, or Spanish white mixed with charcoal dust, and dry in a stove-room. This coat is to prevent the copper deposit from losing its shape and being oxidized by the heat. The interior of the article is then to be filled with the softest brass solder, and powdered borax, which are melted by a gas or turpentine blowpipe. All the hollow parts are soon filled with the solder, which imparts to them as much firmness and durability as is to be found in cast articles.

Removing the Mould.—With a metallic mould, after having removed the useless portions of the deposits, pass a card or a blade of ivory between the model and the deposit. The operation is the same with moulds of plaster of Paris, porcelain, marble, glass, or wood; but it is difficult to save a plaster mould which has been in the bath, and which is nearly always sacrificed. Moulds of wax, stearine, fusible metal, gelatine, or gutta-percha are softened in boiling water, and their separation presents no difficulty whatever.

Finishing up the Articles.—The articles when separated from the moulds are generally spotted with plumbago, grease, or other substances from the moulds. It is usual to heat them, so as to burn out the impurities, and to cleanse them by immersion in a pickle of diluted sulphuric acid. The heating renders the copper deposit softer and more malleable; but it may result in injury to the minute details and the fineness of the copy. Therefore, for delicate works, it is preferable to clean with alcohol, turpentine, or benzole, and to rub the surface with a stiff brush; finish with a paste of Spanish white in water, which let dry upon the object before it is wiped out. Should any Spanish white remain in the hollows, it may be dissolved in water holding one-tenth of its volume of hydrochloric acid, which does not corrode the copper. Complete the operation by rinsing in fresh water, and drying in sawdust or otherwise. When it is desired to anneal the articles without injury to their surface, plunge them into boiling colza or linseed oil, or simply grease, which will bear a heat sufficient for annealing, and will prevent the oxidizing action of the air. This annealing in fatty substances is to be recommended in the case of highly undercut moulds of gutta-percha, which may have left part of their substance in the deep recesses of the copy. The gutta-percha is first softened, and then dissolved in the fatty material.

GALVANOPLASTIC OPERATIONS WITH GOLD OR SILVER.—The processes are more difficult and less effective than those for copper. In the case of non-conducting and deeply-wrought moulds, after having deposited by the ordinary process a thin coating of copper, the whole is plunged into the silver bath,

which then works very well. After the separation of the copy from the mould, allow it to rest in a solution of ammonia or of very dilute nitric acid, which, after a time dissolves the copper, and leaves the silver deposit. This reproduction must be imperfect, as there is, between the mould and the precious metal, an intermediate layer of copper of unequal thickness. When the surfaces are but slightly in relief, employ moulds of lead, tin, or fusible metal, upon which silver or gold will deposit well and without adherence. Lead is preferable to the other metals, especially when the mould may be obtained by pressure. Cover the pattern with a very thin foil of lead larger than the object, the gutta-percha is applied upon it, and pressed, as before explained. The lead foil, without being torn, will follow all the details of the pattern, and may be separated afterwards with the gutta-percha which it has metallized. Instead of lead, silver or gold foils may be used, and are so thin that the seams disappear by simple pressure. A somewhat thick sheet of very pure lead may be employed for taking moulds of engravings upon copper or steel. The lead and the engraved plate are to be passed between rollers, or simply pressed under a screw press.

Baths for Silver and Gold.—The bath for silver is composed of distilled water, $1\frac{3}{4}$ pint; cyanide of potassium, 7 oz.; nitrate of silver, fused, $2\frac{1}{2}$ oz. The gold bath is made of distilled water, 2 pints; cyanide of potassium, 6 oz.; neutral chloride of gold, 2 oz. In this case, the weight of the chloride of gold, and not that of the metal employed for its preparation. These baths generally work with separate batteries, and with anodes of the metal used in the solution, or the porous cells and zincs may be put into the bath itself, provided that the exciting liquor be a more or less concentrated solution of cyanide of potassium. The zincs must not be amalgamated, unless in separate batteries. Green gold is obtained by mixing 10 parts of gold bath with 1 of silver bath, or by employing for a time a silver anode in the gold solution. The deposits of gold and silver, after their separation from the mould, should be heated and scratch-brushed; and a proper shade may be given to them by a short sojourn in ordinary electro-gilding or silvering baths.

Galvanic Etching.—The most simple process consists in covering entirely a copper plate, with an insulating varnish, which is not acted upon by the bath, and then in tracing the drawing with a graver, which must penetrate through the coat of varnish, and expose the copper. By using this plate as the soluble anode of a bath of sulphate of copper, and suspending another copper plate at the negative pole, the latter will receive the deposit, whereas the former will become hollow at the places uncovered by the graver. The engraving produced will only need a slight finishing up. Instead of using varnish as an insulating material, a metallic film, which cannot be dissolved in the bath, may be used. If the copper plate is strongly gilt with the battery, the gilt portions will remain entirely unacted upon, as the acid of the sulphate of copper does not dissolve gold. It is equally easy to produce a drawing in relief, by making the drawing with some insulating material like varnish or a lithographic pencil. The uncovered portions around the lines of the drawing will become hollow, and the image will be in relief. The baths employed generally hold in solution the same metal as that to be engraved; thus, baths of sulphate of copper are used for etching copper plates, solutions of sulphate of zinc for zinc plates, and gold or silver baths for the corresponding metals. Copper and zinc plates may be engraved by the battery, in a simple bath of water with a little sulphuric, acetic, or nitric acid. Upon a varnished plate of copper, a drawing is traced; this plate is dipped into a weak solution of nitrate of binoxide of mercury, and then set perfectly level. By covering it with metallic mercury, this becomes fixed upon the lines traced by the graver, and all the drawing is reproduced in relief by the mercury. Cover the plate with a thin paste of plaster of Paris, and when the latter has set the two moulds are separated,

and the mercury still adheres to the copper. The plaster mould may be treated either for getting a counter-mould from it, or for directly obtaining a galvanoplastic deposit after its metallization. 2. The copper plate is varnished as above, and with the graving tool the parts which will produce the blacks of the engraving are uncovered. A solution of neutral protochloride of zinc is poured upon the plate, and a quantity of fusible metal, fusible at from 190° to 212°, is melted by means of an alcohol lamp moved about under the copper plate. The same result is obtained as with the mercury, except that the mould may be immediately reproduced by galvanoplastic methods.

Composition for Rendering the Decomposing Baths Impervious.—A well-joined and screwed, or bolted, oak bath will last from 12 to 15 years, if coated with a mixture composed of;—Burgundy pitch, 6 parts; gutta-percha, old and cut into small pieces, 1; finely-powdered pumice-stone, 3. Melt the gutta-percha, and mix it, by kneading, with the pumice-stone, then add the Burgundy pitch. When these three substances are thoroughly mixed and in the liquid state, several coats must be spread over the inside of the trough. The angles and corners require a greater proportion of material, which is run in by means of an iron ladle. These various coats are at first coarse and irregular; an even surface is obtained by a heated flat-iron and a soldering iron for the angles. The heat increases the adherence and the penetration of the wood. The exterior of the trough and the iron parts are varnished, either with a fat varnish or the residuum of some turpentine varnish. A trough thus prepared will resist galvanoplastic baths at 28° Baumé, composed of sulphuric acid and sulphate of copper, and even pure nitric or sulphuric acid, provided that neither of these latter remain long in it; but it will not stand the cyanides.

Deposits to Imitate Mosaic Work.—Cut an open pattern upon a sheet of copper, spread it even upon another metallic plate, and dip the whole into a bath of silver or gold, the empty spaces will be filled with the new metals; or a pattern may be hollowed out with a graver from a plate of ivory or mother-of-pearl, and the whole metallized and immersed in the galvanoplastic bath. When the whole surface is covered with the metallic deposit, grind and polish it until the reliefs of ivory or mother-of-pearl reappear, and the metal will form the relief.

Bronze, for Medals.—This operation is to give to new metallic objects the appearance of old ones, by imitating the characteristic appearance imparted by age and atmospheric influences to the metals or metallic compounds, and especially to copper and its alloys. 1. The most simple bronze is obtained by applying upon the cleansed object a thin paste made of water with equal parts of plumbago and peroxide of iron, with a certain proportion of clay. Then heat the whole, and when the object is quite cold, brush in every direction for a long time with a middling stiff brush, which is frequently rubbed upon a block of yellow wax, and afterwards upon the mixture of plumbago and peroxide of iron. This process gives a very bright red bronze, suitable for medals kept in a show case. 2. This bronze may also be produced by dipping the article into a mixture of equal parts of perchloride and nitrate of sesquioxide of iron, and heating until these salts are quite dry. Then rub with the waxed brush as described. 3. Cleanse the article, and cover it with hydrosulphate of ammonia, which allow to dry, then brush with peroxide of iron and plumbago, and afterwards with the waxed brush. If the piece impregnated with hydrosulphate of ammonia is gently heated a black bronze is obtained, which being uncovered at certain places produces a good effect.

Bronze for Zinc.—The zinc to be bronzed must receive an electro-deposit of brass, which is then dipped into a weak solution of sulphate of copper for a red tinge. When dry, wet with a rag dipped into hydrosulphate of ammonia, or a solution of polysulphide of potas-

sium, or protochloride of copper dissolved in hydrochloric acid. After another drying, the surface is brushed over with a mixture of peroxide of iron and plumbago, according to the tint desired. The brush may be slightly wetted with essence of turpentine, which aids the adhesion of the powders. The raised parts are strongly rubbed to uncover the brass. Afterwards give a coat of colourless varnish.

Antique Bronze.—Dissolve in 20 parts by weight of ordinary strong vinegar 3 parts of carbonate or hydrochlorate of ammonia, and 1 each of common salt, cream of tartar, and acetate of copper, and add some water. When an intimate mixture has been obtained, smear the copper object with it, and let it dry at the ordinary temperature for nearly 48 hours. After that time the object is entirely covered with verdigris of various tinges. Then brush the whole, and especially the reliefs, with the waxed brush. If necessary, the raised parts are set off with chrome yellow, or other suitable colours. Light touches with ammonia give a blue shade to the green portions, and carbonate of ammonia deepens the colour of the parts on which it is laid.

Black Bronze.—A steel bronze is obtained by wetting the copper articles with a diluted solution of chloride of platinum, and slightly heating. This bronze will sometimes scale off by friction. It may also be obtained by dipping the cleansed copper into a weak warm solution of chloride of antimony in hydrochloric acid. But sometimes the colour is violet instead of black.

Bronze Powders. — Bronze powders made of impalpable brass are applied upon metals to imitate bronze, and also upon articles of plaster of Paris, and ceramic wares. After the object has been cleaned, it receives a thin coat of fatty drying varnish, which is allowed to become nearly dry. The bronze powder is then laid on with a brush, and adheres strongly. After drying, cover it with a coat of transparent colourless varnish. This process is only suited to large pieces which are imperfectly finished, and will not do for reproductions intended to respect the small details.

Acetate of Copper, *Neutral.*—It is found in the trade either in dark green crystals, or as a bright green powder soluble in water, which becomes green; very soluble in ammonia, and the solution is of a sky-blue colour; it is used for preparing electro-baths of copper and brass; manufactured with copper corroded by fermenting grape-mash, and by other processes.

Acetate, or Sugar, of Lead.—This is usually in masses formed of needle-like crystals; white; light, although having lead for its base; very soluble. Obtained by dissolving litharge or protoxide of lead in an excess of vinegar or acetic acid. Its solution forms, with caustic potash or soda, a white precipitate which is soluble in an excess of alkali, and then constitutes the bath for coloured rings.

Acetic Acid.—It is more or less concentrated and pure, according to the mode of manufacture. Wood vinegar or pyroligneous acid is employed in large quantities, and is colourless or more or less yellow. It often possesses an empyreumatic smell, and generally marks 8° of the hydrometer for acids. Wine vinegar is more or less coloured, and may be concentrated. Crystallizable acetic acid is obtained by the distillation of perfectly dry acetate of soda, or acetate of lead, with concentrated sulphuric acid. The vapours are condensed in a glass receiver, which should be surrounded by ice, sometimes mixed with common salt.

Nitrous and Hyponitric Acids.—These two acids are of an orange-yellow colour, more or less deep, and are always produced by the action of nitric acid upon a metal. The smell is flat and nauseous, and it is dangerous to inhale much of these gases. They colour aquafortis yellow, and also impart a greenish tinge to metallic solutions, those of silver for instance, which may appear as holding copper. This colouration disappears by heating, which it will not do if copper be present. They are abundantly pro-

duced during the cleansing of copper and its alloys in aquafortis.

Nitric Acid.—Called also aquafortis or spirit of nitric. It is bought at 40° Baumé, colourless or dark yellow; and at 36° Baumé, colourless or more or less deep yellow. This colouration is generally due to the presence of nitrous gases, and is perfectly satisfactory for cleansing copper; but it sometimes results from the presence of hydrochloric acid, thus forming aqua regia, or, what is worse, of iodine, bromine, or chlorine, and then the cleansing processes with it are unsuccessful. Pure nitric acid is absolutely necessary for the preparation of nitrate of silver. The presence of chlorine, hydrochloric acid, or sulphuric acid will transform a part of the metal into insoluble, or scarcely soluble, compounds. A pure nitric acid is obtained;—1. By distilling in a large glass retort the commercial article, and collecting the product only when it no longer produces a precipitate or turbidity in a solution of nitrate of silver. The distillate is then collected into a glass receiver and cooled with fresh water or ice. The operation is terminated when about five-sixths have been distilled, otherwise the sulphuric acid will also pass over. 2. By precipitating with nitrate of silver and nitrate of baryta, the hydrochloric and sulphuric acids of commercial aquafortis, and then distilling the whole nearly to dryness. The residuum in the retort is composed of sulphate of baryta, chloride of silver, and the excess of the nitrates of these two bases. 3. By distilling in a glass retort a mixture of 100 parts of pure nitrate of potash with 60 of pure concentrated sulphuric acid and 40 of distilled water. The heat is gradually raised, and stopped when, after having disappeared, the yellow vapours reappear. The acid thus obtained is slightly yellow, and is bleached, by heating it to near the boiling point.

Boracic Acid is obtained in the form of scales by decomposing, with a powerful acid, a concentrated and boiling solution of borax; the boracic acid crystallizes by cooling. It is used for making platinum adhere, by the heat of a muffle, to ceramic wares; thus causing the metallization of surfaces which were not naturally conducting. It is also employed for increasing the whiteness of silver alloys, and for the decomposition of the subsalts deposited in electro-baths containing cyanide of potassium.

Hydrocyanic Acid, or Prussic Acid.—Diluted hydrocyanic acid is colourless, although it is often coloured by a small proportion of Prussian blue, which does not change its properties, with a bitter taste, and the characteristic smell of bitter almonds or peach-tree flowers, although less aromatic, more pungent and deleterious. It is prepared by introducing into a large retort fixed to a receiver, which is cooled by ice, $2\frac{1}{5}$ lbs. of the double cyanide of iron and potassium, yellow prussiate of potash, $1\frac{3}{4}$ pint of water, and $3\frac{1}{3}$ lbs. of concentrated sulphuric acid. The acid and water should be mixed beforehand and allowed to cool. The distillation is effected in a sand bath, and the condensed liquid is clear and colourless. The operation must be stopped when the substances in the retort begin to swell up, otherwise a certain proportion of cyanide of iron and sulphate of potash will pass into the receiver. Avoid inhaling the vapour produced during this preparation. Hydrocyanic acid may also be obtained by passing a stream of washed sulphuretted hydrogen through a tall glass vessel holding water and cyanide of mercury. The latter compound is transformed into the insoluble sulphide of mercury, whereas the hydrocyanic acid remains in solution. After filtering, the liquor is gently heated in order to expel the remaining sulphuretted hydrogen, which is more volatile than hydrocyanic acid. This method is not so simple as the preceding one, and is open to the inconvenience of often having the acid contaminated with undecomposed cyanide of mercury or sulphuretted hydrogen. Hydrocyanic acid is employed for maintaining the metal strength of gold dipping baths with pyro-phosphates, and for decomposing the alkaline carbonates formed in baths with cyanide of potassium.

Hydrochloric Acid, Spirit of

Salt.—During the preparation of this acid, it is gaseous, and emits abundant and thick fumes in contact with the air. Water, at the temperature of 70° Fahr., dissolves 460 times its own volume of this acid. This solution is always employed in the arts, and is generally contaminated with sulphurous and sulphuric acids, and by perchloride of iron, imparting a yellow colour to it. It is employed for preparing the chlorides of certain metals, for instance that of zinc; it enters into the composition of aqua regia; and the common salt, added to certain cleansing acids, is intended to form a small quantity of hydrochloric acid. It is prepared by introducing common salt into a glass balloon, and an excess of commercial sulphuric acid. A gentle heat is gradually applied, and the gas is collected and dissolved in a series of tubulated bottles. These receivers should be constantly cooled by a stream of water or by ice, because the elevation of temperature caused by the combination of the water and acid, would prevent the liquid from becoming thoroughly saturated. The first bottle contains but little water, and is intended to arrest the impurities mechanically carried by the gas. The glass balloon, after the operation, contains acid sulphate of soda.

Hydrofluoric Acid.—Hydrofluoric acid is prepared by decomposing in a lead retort a paste of fluoride of calcium and sulphuric acid. The various joints of the retort are carefully luted with clay or plaster of Paris, and the receiver is a bent tube of lead plunged into a mixture of 3 parts of broken ice, and 2 of common salt, or more simply, into ice alone. The end of the receiver is perforated with a small hole, in order to aid the condensation by a small pressure. A gentle heat is applied at the bottom of the retort. This acid must be kept in lead bottles which are but slightly acted upon, or in platinum vessels, upon which it has no action whatever; gutta-percha bottles have been substituted for the metallic ones, and appear to stand the acid well when it is not too concentrated. Avoid any contact with the vapours of hydrofluoric acid, otherwise after a few hours the skin will be covered with painful blisters.

Stearic Acid.—This acid is white, and more or less greasy to the touch; it melts at a temperature from 140° to 150° Fahr. into a clear liquid, which again solidifies by cooling. It is this property which renders stearic acid valuable for taking casts. If too greasy it will stick to the pattern, and especially to plaster of Paris coated with plumbago; in this case it should be mixed with a certain proportion of wax or spermaceti. When too dry it contracts considerably by cooling, often breaks, and the galvanoplastic deposits have a crystalline surface. This defect is corrected by tallow or olive oil.

Hydrosulphuric Acid.—Generally in the gaseous form, but may be dissolved in water, which absorbs two or three times its own volume of it at the ordinary temperature, and then acquires the same properties as the gas itself. Hydrosulphuric acid is obtained by the reaction of hydrochloric acid, or diluted sulphuric acid, upon many sulphides, such as those of antimony, iron, barium, or strontium. The gas is collected under receivers filled with mercury, or is dissolved in an apparatus such as that described in the manufacture of hydrochloric acid. The distilled water employed should be deprived of air by boiling, otherwise the solution will be milky from the partial decomposition of the acid. Be careful not to bring in contact with this gas metallic salts, gilt or silvered articles, or even pure gold and silver, which are rapidly blackened by it.

Tannic Acid.—This acid is generally prepared by digesting powdered gall-nuts, at a temperature of about 90° Fahr., in commercial ether, and in closed vessels. After about eight days the settled liquid, which is quite syrupy, is decanted and spread upon many dishes, which are put into a stove. The ether is evaporated, and the nearly pure tannic acid remains in uncrystallized scales, which are light, thin, yellowish, and with the lustre of mother-of-pearl. It is purified by solution in boiling

water, which, by cooling, allows it to deposit in the shape of needle-like crystals. Tannic acid possesses the singular property of rendering insoluble certain gums, gluten, and gelatine especially, the latter being transformed into a kind of leather which will not putrefy.

Gold Amalgam.—Amalgam is the name given to alloys of metals with mercury, but the latter must absolutely be one of the component parts. Whatever be the proportions of gold and mercury put together, an amalgam is always formed; but there are certain proportions which are more or less favourable for obtaining a certain result. The gold amalgam for gilding by stirring should be more fluid, and therefore contain more mercury, than that prepared for gilding by fire for a dead lustre, or for ormolu. The latter should be of the consistency of hard cold butter, a little rough to the touch, and with a crystalline texture which causes the production of a noise when the amalgam is pressed between the fingers. That for gilding by stirring should be of the consistency of honey and quite soft. An amalgam is generally prepared by heating distilled mercury to a temperature of about 390° F., and adding to it foils or ribbons of gold, which readily incorporate. The whole is then thrown into cold water. If the proportion of mercury has been too great, the amalgam may be heated over the fire, until part of the mercury is volatilized, and the proper consistency is reached. Should the amalgam be too hard, an addition of mercury will soon mix with the mass. When an amalgam is heated at a dull red heat, all the mercury is volatilized, and the gold remains in the form of a spongy and crumbling mass.

Ammonia.—Ammonia is obtained by treating any kind of ammoniacal salt by a fixed alkali. Sulphate or hydrochlorate of ammonia is generally employed, and is heated in a stoneware retort with slaked lime. The gas produced is received either under glass bells or tubes filled with mercury, if we desire to keep it in the gaseous state; or is dissolved in the water contained in tubulated bottles if its solution is desired. After the operation there remains in the retort sulphate of lime or chloride of calcium. Ammonia is employed for aiding the solution of the copper salts entering into the composition of the baths for electro-deposits of copper or brass, for ageing freshly-made silver baths, for precipitating gold ammonium from the chloride of gold, and for dissolving the film of copper deposited at the beginning of galvanoplastic operations with silver, &c.

Silver.—The silver found in the trade, even under the name of virgin silver, retains traces of copper. Silver is purified by several methods;—1. The impure metal is dissolved by nitric acid, and the solution being largely diluted with water, add to it an excess of a filtered solution of common salt. An abundant white precipitate of chloride of silver is produced, which rapidly settles to the bottom of the vessel. All the silver salt is decomposed when the clear liquid is not rendered turbid by a further addition of common salt. The chloride of silver is collected, and washed several times, until the liquors are no longer coloured brown by yellow prussiate of potassa. This is the proof that all the copper has been washed out. The washed chloride of silver is mixed with two or three times its own weight of carbonate of soda, dried, and melted in a crucible. After cooling, the metal is found in a conical button at the bottom of the crucible. To granulate it, the molten silver is poured from a certain height, about 3 ft., into a large volume of water. 2. The alloy of copper and silver is dissolved in nitric acid, and the solution evaporated until the salts fuse. After cooling, the fused mass is gradually thrown into a red-hot crucible, when the nitric acid escapes, leaving behind the silver in the metallic state, and the copper as oxide. The separation of the two takes place naturally, and is aided by the addition of dry borax, which dissolves the oxide of copper. Silver is easily dissolved in pure nitric acid, but not so rapidly in one contaminated by chlorine or hydrochloric acid, which produces a coat of chloride of silver around the

metal, and therefore forms an obstacle to its solution. Sulphuric acid also combines with silver, and the resulting salt is but slightly soluble. Pure silver is employed for the preparation of the nitrate and other silver salts, and for soluble anode in silver baths.

Nitrate of Silver, or Lunar Caustic.—This salt is found in the trade under three forms; either as crystallized nitrate of silver in thin transparent plates; or in amorphous, opaque white plates of fused nitrate; or in small cylinders, which are white, or grey, or black, according to the nature of the mould employed, and constitute the lunar caustic for surgical uses. The crystallized nitrate of silver still retains a small proportion of nitric acid and water; the white fused one is pure when it has not been fraudulently adulterated by nitrate of potash or soda. The third kind, or lunar caustic, generally has its surface coated with a film of reduced silver and of oxide of copper from the moulds; its colour may also be due to the inferior quality of the silver employed. Nitrate of silver is prepared by dissolving pure silver in double its own weight of pure nitric acid at 40° Baumé, in a glass flask or in a porcelain capsule. Abundant nitrous vapours are disengaged, and the metal soon disappears to form a colourless liquid, blue or green if there be copper. After cooling, and a rest of a few hours, a mass of crystals of nitrate of silver is found, which is drained and washed with a little distilled water already saturated with nitrate of silver, in order to remove the excess of acid. The crystals are dried in a stove, and kept away from solar light. If, instead of cooling the liquid after the silver has been dissolved, the evaporation be continued, the mass will become spongy, and then fuse by a greater heat into a greyish liquid which may be run into moulds. The fused mass, obtained by the fusion of the separated crystals of nitrate of silver, is whiter. This salt, whatever be its mode of preparation, should be kept in black or blue bottles; it is employed for preparing baths, metallizing moulds, and many other purposes.

Nitrate of Binoxide of Mercury.—This salt is used for slightly amalgamating the pieces which are to be silvered or gilt. It is obtained by dissolving at the temperature of about 212° F. some mercury in double its own weight of nitric acid at 40° Baumé, and continuing the heat until yellow fumes no longer appear.

Nitrate of Potash, or Saltpetre.—Nitrate of potash is colourless, and has a salt taste; it is very soluble in water, and a concentrated solution deposits, on cooling, fine prismatic crystals, which are more or less translucent. Distilled in closed vessels with more or less diluted sulphuric acid, nitrate of potash produces nitric acid, or aquafortis of various degrees of concentration. Saltpetre is used for producing a dead lustre upon objects gilt by fire, and for desilverizing baths.

Bicarbonate of Potash.—This is white and colourless, and crystallizes either like nitrate of silver, or like common salt or iodide of potassium. It is soluble in tepid water, without decomposition; but at the boiling-point it loses one-fourth of its carbonic acid and becomes a sesquicarbonate. This is employed for the preparation of certain gilding baths by dipping, and for that of the ordinary cyanide of potassium, is obtained by conducting a stream of carbonic acid through a concentrated solution of carbonate of potash, until the liquor is no longer rendered turbid by the addition of sulphate of magnesia or nitrate of lime.

Bitartrate of Potash, Cream of Tartar.—This salt is nearly pure in wine, from which it separates in the shape of small white or red crystals, according to the colour of the liquid. It is gathered on the sides of wine casks, and purified by bone black. The price of cream of tartar varies with that of wine. This substance is often adulterated with alum, saltpetre, &c. It is therefore preferable to buy it in the crystallized form, and to pulverize it in the shop. It is employed for the preparation of the whitening silver baths, for those of tin, and for the silvering paste by rubbing.

India-rubber.—This substance is white when pure; but its colour is generally brown or red, caused by the smoke of the fires employed for drying it. Water, alcohol, and acids do not dissolve india-rubber; ethers, bisulphide of carbon, essential oils, and benzole dissolve and abandon it after their volatilization. These solutions give the means of obtaining very delicate moulds. Apply it in very thin and successive coats, otherwise the exterior surface being the first to solidify, will prevent the drying of the intermediate coats.

Chloride of Silver.—This substance turns black if exposed to the light, it must therefore be kept in blue or black bottles. It melts at a high temperature, and acquires the appearance of horn. When chlorine water, hydrochloric acid, or a soluble chloride is introduced into a solution of a silver salt, there is immediately produced an abundant white precipitate of chloride of silver, which is insoluble in water and in concentrated acids, but soluble in ammonia, cyanides, and the hyposulphites and sulphites of alkaline or earthy bases. This precipitate is but slightly soluble in the bromides, iodides, chlorides, and fluorides of the alkaline or earthy metals. Chloride of silver is employed in the preparation of the baths for electro-silvering, and for whitening, and for the pastes for silvering in the cold by rubbing.

Protochloride of Tin, or Tin Salt.—This salt is greasy to the touch, and melts easily. Protochloride of tin is soluble in water, but is partly precipitated in the state of a white subsalt, which is easily dissolved in a slight excess of acid. Alums, pyrophosphates, tartrates and bitartrates precipitate at first the aqueous solution of this salt, but an excess of the reagent redissolves the precipitate. The protochloride of tin is prepared by dissolving granulated zinc, in excess, in hot hydrochloric acid, evaporating the solution, and letting it crystallize. If the crystals are heated, they first melt in their water of crystallization, which soon evaporates, carrying off a small proportion of hydrochloric acid. This operation is completed when thick, white fumes begin to be evolved, which are proof that the salt itself volatilizes. The melted chloride of tin thus obtained is preferable for tinning with alkaline liquors.

Chloride of Gold.—This salt is in yellow, red, or brown-red needle-like crystals, according as it has been more or less deprived of acid. Chloride of gold is decomposed by light into the metal and chlorine; it should be kept in black bottles, with ground-glass stoppers. Cork, like other organic substances, decomposes this salt. Chloride of gold absorbs the dampness of air, and resolves into a liquid of a fine yellow colour. It produces violet stains on the skin, and is very soluble in water. A diluted solution of chloride of gold is decolourized by sulphurous acid; after a time the metal is precipitated as a powder, which is green by transparency, and red by reflected light. Chloride of gold may be prepared by dissolving the finely-divided metal in aqua regia, formed of 2 parts of pure hydrochloric acid to 1 of pure nitric acid. The operation is effected in a glass flask, and with the aid of a gentle heat, until all the gold is dissolved into a yellow liquid, which retains a great excess of acid. The heat is then slightly increased, and continued until the liquid is a hyacinth-red. After cooling, a crystallized mass of a fine yellow colour remains, which is well adapted to the preparation of the gilding baths by dipping. If for baths working with a battery, continue the action of the fire until the liquid in the flask appears a dark blackish red, without ceasing to be fluid. By cooling, the crystals are brown-red. The flask should stand upon a plate of sheet iron perforated in the centre with a hole, the diameter of which is not larger than the layer of liquid after evaporation. This is to avoid the reduction by an excess of heat of a portion of the chloride of gold. It is preferable to make the aqua regia just before using it.

Bichloride of Platinum.—This salt is amorphous, reddish yellow, or blackish red, according to the degree of

evaporation of the acids in excess. It resembles chloride of gold in appearance and in its deliquescent property, when acid, but it is not so easily decomposed by light and organic substances. Its diluted solution is gold-yellow, and dark yellow when concentrated; but never wine-red, unless it contains palladium, iridium, or rhodium. The chloride of platinum resists the action of the fire better than that of gold; however, at first it becomes protochloride of platinum, and lastly metal. When a brass article is rubbed with chloride of platinum, it acquires the colour and lustre of steel, and this coat is often quite durable. Perfectly neutral chloride of platinum, mixed under a muller with certain fatty and essential oils, furnishes a paste for applying thin coats of metal upon stoneware, pottery, glass, and porcelain. Chloride of platinum is easily soluble in caustic soda, and in the carbonate and phosphate of this base, and thus furnishes more or less satisfactory baths for platinum deposits. This salt is prepared like the chloride of gold; but the aqua regia is composed of 5 parts of hydrochloric acid to 3 of nitric acid. The product is evaporated nearly to dryness in a porcelain dish, and then removed after cooling. If it be desired to have it more acid, and therefore more easy to dissolve, it is poured still fluid, but emitting little fumes, into a porcelain plate, from which it is easily separated after cooling.

Chloride of Zinc. — This substance is grey or white according as it has been prepared in iron or porcelain vessels, and has been more or less dried. It is caustic, greasy, and hot to the touch. It absorbs moisture very rapidly. It may be distilled, and then possesses the appearance of butter. Chloride of zinc is employed for aiding soldering, brazing, or welding operations, and in this case it should be as neutral as possible, in order not to act as an acid upon the metals. It enters into the composition of the brass or zinc baths. It is prepared by dissolving zinc in hydrochloric acid, filtering the solution left for a few days in contact with an excess of zinc, and evaporating it down to igneous fusion. At that moment abundant and thick white fumes are disengaged. The mass is then cast into plates, which are put into well-closed vessels immediately after cooling.

Cyanide of Silver.— This substance is white, becomes slowly black when exposed to the light, and is insoluble in water and in cold acids, which, however, will dissolve it on the temperature being raised sufficiently. It is dissolved and decomposed by the sulphites, hyposulphites, and chlorides; the cyanides and prussiates form with it double salts. A cyanide of silver is always formed when any kind of soluble silver salt is treated by a small proportion of cyanide. Cyanide of silver is prepared by adding hydrocyanic acid to a cold solution of nitrate of silver. The precipitate formed is thoroughly washed, and kept wet in blue or black bottles.

Cyanide of Copper.—This salt, as a powder of a brown colour, is obtained by the precipitation of a soluble copper salt by yellow prussiate of potash, or may be obtained of a dirty white with a greenish-yellow tinge, from the precipitation of a soluble copper salt by cyanide of potassium. Whatever its mode of production, it is easily soluble in all the alkaline cyanides, and even in yellow prussiate of potash, if it has been recently prepared. By solution in an excess of cyanide it forms the double cyanide of potassium and copper for electro-coppering.

Cyanide of Calcium.—This is employed for decomposing the carbonates formed in the baths of cyanide of potassium. A solution of cyanide of calcium is obtained by adding prussic acid to a paste of caustic lime in excess. By filtration, the excess of lime remains behind, and the cyanide of calcium is in the liquor. This salt cannot be obtained in the solid state, is decomposed by heat, and it is better to use it when recently prepared.

Cyanide of Gold.—It is of yellow colour, and acts with reagents very much like the cyanide of silver. Cyanide of gold is prepared by pouring a concen-

trated solution of cyanide of potassium into a concentrated one of chloride of gold. An excess of alkaline cyanide will dissolve the precipitate and form an electro-gilding bath holding a double cyanide of gold and potassium. This salt may be employed for the preparation of gold baths; but it is more expensive, and does not seem to give better results than any other good salt, and particularly the gold ammonium.

Cyanide of Potassium.—No other product is more important to the electroplater than the cyanide of potassium, which is the basis of most of the baths employed, and the purity of which is necessary for the success of the operation. To obtain the cyanide pure, several operations are necessary. 1. The recrystallization of the commercial yellow prussiate of potash until it is entirely free from sulphates. 2. The thorough drying of the pure crystals at a temperature of from 212° to 250° F. 3. The melting at a white heat of the dried prussiate in thick iron crucibles with their covers on. 4. Keeping the contents for some time in a state of quiet fusion, to permit the settling of the iron at the bottom of the crucible. 5. When the surface of the molten cyanide appears transparent withdraw the crucible with iron tongs, and pour its contents, without shaking, upon a polished iron pan, the bottom of which is immersed in water. The iron generally remains in a spongy mass at the bottom of the crucible; but, as a further precaution, the molten cyanide is sometimes passed through a fine metallic sieve, which has been previously raised to a red heat. An iron ladle, perforated with numerous holes, may also be filled with the iron of the previous operations, and the whole being raised to a red heat, the molten cyanide is filtered through it. During the fusion of the cyanide, now and then plunge into it a dry glass rod; if the cyanide gathered upon it is perfectly white and clean, the moment has arrived to pour the contents out. The cyanide manufactured in this manner is cyanide No. 1; it is of a milky white, more or less translucent, and its fracture is crystalline and vitreous. It is completely odourless, when perfectly dry, but if it has absorbed the least quantity of water, it possesses the characteristic smell of the bitter almond. Exposed to the damp air, it soon deliquesces, and is decomposed into carbonates and formiates of potash and ammonia. When a cyanide is to be kept for a long while, it is prepared with a pure yellow prussiate of soda, and the product is rather efflorescent, that is to say, repels dampness instead of attracting it like the cyanide of potassium.

Ordinary Cyanide of Potassium.—Sometimes it is advantageous to substitute for pure cyanide marking 98° or 100° one not so rich, which owes to free potash the property of improving the conducting power of freshly-made baths. The facility of its manufacture allows of a much lower price. The second quality, which contains 75 per cent. of real cyanide, is intended for freshly-made baths, and for those of brass and copper; the third quality, having 55 per cent. of real cyanide, is applied to photographic uses. The following is mixture for No. 2:—8 parts of purified and dried yellow prussiate of potash, and 4 parts of bicarbonate of potash, or 3 parts of pure carbonate of potash; and for No. 3, equal parts in weight of yellow prussiate and pure carbonate of potash. Place in a covered iron crucible and bring to a red heat. The remainder of the operation is the same as has been described for the pure cyanide, except that the temperature does not require to be so high. The trial coating upon the glass rod should be porcelain white. The fracture of these cyanides is more or less crystalline or granular, according as the cooling has been sudden or gradual. The presence of sulphates in the yellow prussiate, or the carbonate of potash employed, will impart a pink, green, or blue colour to the cyanide.

Ferrocyanide of Potassium, or Yellow Prussiate of Potash.—This is in fine yellow, and semi-translucent, crystals, which break gradually and without noise. The fracture is jagged, and filled with a multitude or

small bright spots. The solution of ferrocyanide of potassium is straw yellow, and like the simple cyanide of potassium, precipitates and redissolves afterwards nearly all metallic salts. However, its dissolving power is much less energetic. The soluble anodes are but little dissolved, in baths composed of this yellow prussiate, which renders their use expensive. This cyanide is scarcely poisonous, and does not emit any smell or absorb dampness. It is prepared by carbonizing animal residue, such as blood, horn, hair, &c., with a mixture of carbonate of potash and iron scraps. The mass is then lixiviated with water, and the solution crystallized. For the manufacture of white cyanide of potassium, avoid those crystals of yellow prussiate which, when viewed obliquely, present other small bright crystals of sulphate of potash, as they are injurious to the operation.

Cyanide of Zinc.—This article is costly, and does not present any real advantage over the other zinc salts. It is white or dirty white, according as the zinc salt was without or with iron. It is insoluble in water, but soluble in ammonia, and in the earthy or alkaline sulphites and cyanides, with which it forms double salts, suitable for zinc electro-baths. Its solution is the more easy as it has been more recently prepared. Cyanide of zinc is obtained by incompletely precipitating with cyanide of potassium, a solution of sulphate, nitrate, chloride, or acetate of zinc. The precipitate is drained upon a filter of paper or calico, and washed to remove the remaining soluble zinc salt.

Gelatine or Isinglass.—This article is extracted by acids, or superheated water, from bones, skin, cartilage, and similar substances; it is more or less coloured, according to its degree of purity. The common sorts, or glue, are employed for making galvanoplastic moulds. The least coloured are preferred, because the casts are more delicate. Cold water swells and softens gelatine, but hot water will dissolve it. This property is very useful for the production of the moulds, but is disadvantageous when the mould is in the bath. This inconvenience may be partly remedied by adding to the gelatine, before pouring it upon the pattern, a few hundredths of tannic acid, which with it forms a kind of leather, and resists the action of the liquids better. Gelatine moulds should be rapidly coated with the metallic deposit, otherwise they will give very imperfect copies. Although hot water dissolves gelatine, which sets by cooling, this property disappears after too long a boiling, and the liquid that remains will not coagulate.

Benzine.—Benzine dissolves all the oils, resins, gum resins, varnishes, and fats, and is therefore very useful. It is much superior to alcohol and essence of turpentine, formerly employed for removing resist varnishes, and may be used in the cold, which is a great advantage with inflammable substances. A small quantity of naphthaline gives a pink, red, or brown tinge to benzine; but this is of no consequence.

Phosphate of Ammonia.—Necessary for the composition of baths for thick platinum deposits; it is obtained by the exact saturation of phosphoric acid with ammonia. The liquid is then evaporated at a gentle heat; add a few drops of ammonia now and then to compensate for that removed by the decomposition of small quantities of the salt. When the liquid becomes syrupy it is set aside to crystallize in a cool place. It may also be prepared by decomposing, with carbonate of ammonia, the biphosphate of lime resulting from the digestion in sulphuric acid of ground and calcined bones.

Phosphate of Soda.—This salt crystallizes in fine, transparent, colourless prisms; it effloresces by losing part of its water of crystallization. It is soluble in distilled water without producing any precipitate, but causes a deposit of white phosphate of lime in calcareous waters. This salt is formed of 1 part of phosphoric acid, saturating 2 of soda, and 1 of water acting a base. Phosphate of soda is used for hot electro-gilding baths, and is prepared by treating calcined and powdered bones with

sulphuric acid, and letting the mixture rest for several days. The acid phosphate of lime is then removed by washing the residue, and the filtered liquid is saturated by carbonate of soda until carbonic acid is no longer disengaged. The clear settled liquor is then concentrated until it marks 33° Baumé, and is allowed to crystallize once or several times.

Pyrophosphate of Soda.—The commercial salt is generally in a white powder, soluble in water, but not so soluble as the preceding salt; it requires distilled water, as it produces precipitates in calcareous waters. The pyrophosphate of soda gives a white precipitate with nitrate of silver, whereas that of the ordinary phosphate is yellow. It is employed for the preparation of gilding baths by dipping; and is obtained by fusing the ordinary dried tribasic phosphate, which by this operation loses an equivalent of combined water, and becomes bibasic. The temperature required is high, and few crucibles will stand the heat and the fluxing action of this substance.

Plumbago, or Black Lead.—Nearly pure carbon, black, with a certain lustre, soft to the touch, without smell or taste, and difficult to burn. Plumbago, in the natural state, is generally mixed with a proportion of oxide or sulphide of iron and earths, which should be removed by washing with hydrochloric acid. The best plumbago is very black, and without much lustre, except after rubbing; it should firmly adhere to wax and plaster of Paris articles, and should not detach from them by being immersed into a liquid. The best way to ascertain its quality is to apply a deposit upon it; the sooner it is regularly coated the better it is. It is employed for rendering conducting certain substances which are not naturally so, and for preventing the adherence between two superposed metals. Plumbago is also used for bronzing; but in this case it is useless to purify it with hydrochloric acid. When plumbago is moistened with a solution of chloride of gold in ether, and then allowed to dry in a shallow vessel exposed to solar light, a gilt plumbago is obtained, which is much more conducting than plumbago alone.

Amalgamating Salt.—This is a mercury salt with three acids, and is composed of the sulphate, nitrate, and bichloride of this metal. It is liquid, more or less coloured, very dense, and gives in water a yellow precipitate, which is dissolved by an excess of acid. It produces a violet stain on the skin, and amalgamates copper and its alloys thoroughly and rapidly. It is used for amalgamating the zincs of batteries, and dispenses with the metallic mercury; it is more easily applied, and prevents much trouble in gilding works. It is prepared by boiling the nitrate of binoxide of mercury upon an excess of a powder composed of equal parts of bisulphate and bichloride of mercury; the liquor only, remaining after cooling, is used.

Sulphate of Copper, or Blue Vitriol.—Easily soluble in water, especially when the latter contains some free acid, and the solution is blue. Hot water dissolves much more of this salt than cold, and it crystallizes by cooling. The solution of sulphate of copper constitutes the galvanoplastic baths, which are rendered more conducting by the addition of $\frac{1}{10}$th in volume of sulphuric acid. Many kinds of commercial sulphate of copper are impure, and have variable proportions of the sulphates of iron and zinc, which are injurious when their amount is too great. Sulphate of zinc is detected by passing through the acid solution a current of sulphuretted hydrogen gas. The sulphide of copper produced is separated by filtration, and the clear liquor is treated by ammonia, which produces a white precipitate of oxide of zinc, soluble in an excess of alkali. The iron remains also in the acid liquor filtered from the copper, and its presence is ascertained by the red prussiate of potash, which gives a blue colour. Another process for the detection of iron is to add to a small quantity of the solution of sulphate of copper

enough ammonia to dissolve all the oxide of copper precipitated at first, and the brown oxide of iron will be seen floating in the blue liquor. The best sulphate of copper comes from the refining of silver coin by sulphuric acid, or from the solution in the same acid of the scales of copper oxide produced in rolling sheets of this metal. Avoid cheap copper sulphates extracted from old acid dipping liquors, as they contain zinc and other metals, and also nitrate of copper with free nitric acid. These sulphates are generally very wet, and in small crystals.

Sulphate of Protoxide of Iron, or Green Copperas.—This salt crystallizes like the preceding one, and is of a fine green colour. It is very soluble in water, and is rapidly oxidized by contact with the air. The sulphate of protoxide of iron is employed for precipitating gold from its acid solutions. It is prepared either by evaporating and crystallizing the liquors used for cleansing iron, or by the oxidization in the air of iron pyrites. The salt obtained by this latter process generally contains some copper, which is precipitated by iron scraps put in the solution.

Sulphate of Mercury. — Prepared by heating in a porcelain dish 1 part of mercury with 2 parts of concentrated sulphuric acid, and completely drying the product. Great quantities of sulphurous acid, and then of sulphuric acid, are disengaged during the operation; when nearly dried the paste should be constantly stirred with a glass rod.

Sulphate of Zinc is either in white or opaque plates, in large transparent crystals, or in a mass formed of a quantity of crystals, it is very soluble in water, which remains colourless. Sulphate of zinc is employed for zinc and brass electro-baths, in the preparation of acids for a dead lustre, and for a frosted lustre upon clocks and jewellery.

Sulphite and Bisulphite of Soda.—The former forms white crystals, which are rapidly transformed into an amorphous powder by efflorescence. It is very soluble in water, and is gradually transformed into sulphate by the absorption of the oxygen of the air. Sulphite of soda, and generally all the soluble sulphites, dissolve the salts of gold, silver, or copper, and transform them into double colourless salts, which possess more or less stability, and are employed for electro-baths. The sulphite of soda may absorb an excess of sulphurous acid, and thus become a bisulphite, which should always be preferred to the neutral salt. The neutral sulphide of soda is prepared by passing a stream of sulphurous gas through a solution of carbonate of soda until the liquor neither turns red litmus paper blue, nor reddens a blue one. If the solution is very concentrated, a quantity of small crystals of bicarbonate of soda precipitate during the operation, and should be stirred to prevent them from obstructing the gas tube. An excess of sulphurous acid decomposes them with abundant production of carbonic acid. The saturated liquor crystallizes by cooling if concentrated; in the other case it should be evaporated to a certain point. The bisulphite of soda is produced by continuing the passage of the sulphurous gas until the solution reddens, and even destroys the colour of blue litmus paper. This salt in the air loses its excess of sulphurous gas, then becomes neutral sulphite, and, after a long time, sulphate of soda, by the absorption of oxygen.

Sulphide of Ammonium. — This is prepared by saturating ammonia with sulphuretted hydrogen gas. It is generally used with an excess of sulphur, that is to say, after it has been kept for a few hours with an excess of flowers of sulphur, and at a temperature of about 160° Fahr. The liquid is then of a dark reddish-yellow. It may also be prepared by the decomposition of the sulphide of barium, calcium, or strontium, by carbonate of ammonia. Avoid opening a bottle of sulphide of ammonium in silver-plating rooms.

Sulphides of Calcium, Potassium, and Sodium.—These salts are obtained in solution by boiling the

alkali and the flowers of sulphur in a certain quantity of water. They are produced in the dry way by projecting powdered quicklime or potash or soda into melted sulphur, and then casting the mixture on a marble slab. The dry sulphides are generally in plates, which are greenish or whitish at the surface and reddish yellow inside. They are soluble in water, which is coloured yellow or red, according to the degree of concentration. Their uses are the same as those of sulphide of ammonium.

Bisulphide of Carbon.—Bring to a red heat a stoneware or porcelain tube filled with charcoal and in connection with a condensing receiver, and then introduce fragments of sulphur into it, and immediately close the aperture, the liquid which results from the combination of the sulphur and carbon is condensed at the bottom of the water in the receiver, and, after a distillation in another vessel, is a pure bisulphide of carbon. It is a colourless transparent liquid, which is very dense, and possesses the double refraction. Bisulphide of carbon dissolves many kinds of resins, fats, and gum resins, such as india-rubber and gutta-percha, and also sulphur and phosphorus. This last solution is employed for reducing the nitrate of silver to the metallic state upon certain moulds, which thus become conducting. Sulphide of carbon is now obtained in the trade at a very low price; when pure it should volatilize without leaving any residue.

Stirring Rods.—These are made of various substances, and are employed for mixing; those made of glass, stoneware, or porcelain are the best in most cases. Wood and most metals should be avoided, because the former is absorbing, and the latter are corroded and easily oxidized.

Anodes.—These are the plates or wires of different metals, placed at the end of the connecting wire starting from the positive pole of a battery. The anodes are soluble or insoluble, that is, they either dissolve under the influence of the galvanic current to partly maintain the metallic strength of the bath, or they simply bring the current into the bath without being dissolved. Generally the soluble anodes are of the same metal with which the bath is composed; and the insoluble anodes are of platinum, graphite of gas retorts, carbon, or any other conducting and insoluble substance. Soluble anodes are generally completely immersed in the solution, and connected with the conducting wire by other platinum wires. Insoluble anodes are rarely completely immersed; dipping them more or less increases or diminishes the amount of electricity.

Mixtures employed in gilding by fire or by the wet processes.

Red Ormolu.—Potash alum, nitrate of potash, 30 parts of each; sulphate of zinc, 8; common salt, 3; red ochre, 28; sulphate of iron, 1. Add to it a small proportion of annatto, madder, cochineal, or other colouring matter, ground in water or in weak vinegar.

Yellow Ormolu.—Red ochre, 17 parts; potash alum, 50; sulphate of zinc, 10; common salt, 3; nitrate of potash, 20.

Dead Lustre for Jewellery.—Sulphate of iron, sulphate of zinc, potash alum, nitrate of potash, equal parts of each. All the salts are melted in their water of crystallization.

Hard Dead Lustre for Clocks.—Water, 5 parts; nitrate of potash, 37; potash alum, 42; common salt, 12; pulverized glass and sulphate of lime, 4. The whole is thoroughly ground and mixed.

Soft Dead Lustre for Smooth Surfaces and Figures.—Water, 5 parts; nitrate of potash, 46; potash alum, 46; common salt, 3. The same treatment as the preceding mixture.

Green for Red Lustre.—Bitartrate of potash, 65 parts; common salt, 25; acetate of copper, 10. The whole is ground together.

Wax for Gilding.—Oil, 25 parts; yellow wax, 25; acetate of copper, 13; red ochre, 37. The whole is melted, and stirred until cold.

Photography. — *The Operating Room* should be in an elevated position, the south side entirely closed, the north side being glazed with tolerably thick glass, as free from colour as possible,

but preferably of a blue tint, to anything at all approaching green or yellow, as these colours, by neutralizing the light, tend to prolong the photographic operations. If possible the length of the room should run from east to west, and the ends be protected from the morning and afternoon sun. A room lighted only from the north side has the softest and most uniform light that can be obtained. Part of the roof may be glassed, and curtains of a bluish colour should be fixed, with an arrangement of cords and pulleys, by which they may easily be adjusted to admit light, or cast a shadow in the required direction. The colours of the wall must be carefully chosen, avoiding red, yellow, or green; a bluish grey is the safest, and may be used of several tints to give variety. Movable backgrounds painted in different depths of colour are useful to modify the result of any ill-chosen colours worn by the sitter. Oil colour must be avoided for walls or backgrounds; a mixture of slaked lime, litmus, or lampblack may be employed, varying the quantity of lampblack to give the required shade. In the choice of dress, the sitter must remember that cold colours, such as blue or violet, come out white in photographs, whilst the warm colours, red, orange, or yellow, give various shades of black. Articles of dress with vertical stripes tend to give an appearance of increased height to the portrait. The sitter should assume an easy natural position, avoiding a direct vertical light, which falling on the top of the head gives to dark glossy hair the appearance of greyness, and throws very heavy shadows under the eyes, nose, and chin. The best position is a little back from under the skylight, with the head slightly retiring from the side light. The whole figure is then well illuminated; the deepest shadow on the face will be on the retiring cheek, in a three-quarter view, which is generally the best to take. The partial profile will be clearly defined on the shadowed cheek. The position of the body in relation to the head is a matter of taste. The distance of the figure from the background, and its height on the plate, are points which must be regulated by the artistic skill of the operator. If the sitter is placed several feet in front of the screen, the picture will have greater relief, and the apparent height of a person is much affected by the position of the portrait on the plate. Avoid overcrowding the background with vases, columns, and curtains, or anything which will divert the attention from the principal object; as a rule a plain background is the best, the introduction of superfluous furniture and ornamentation most frequently gives a photograph an unpleasant tone of vulgarity. If the head-rest is used, it must be carefully adapted to the head, which should only lightly press on it. When the position is settled and the focus arranged, the sitter should not alter his attitude, though perfect immobility is unnecessary. When the operator has the plate ready to expose, he should caution the sitter to keep the eyes fixed in one direction, and to remain perfectly steady; he may then uncover the lens. The nearer the camera is brought to the sitter, the longer the exposure; thus the time of exposure may be varied from one second to 300 seconds. As a general rule, for a full-length figure, in summer, the plate should be exposed 20 seconds; a sitting portrait will require 30 seconds. In winter the exposure must be increased in duration one-half.

Dark Room.—During certain parts of the process it is imperative that the operator should work in a room into which not a ray of direct light is admitted. This is usually effected by closing every window but one, and that is carefully obscured by yellow or orange coloured curtains, or calico cloth, or a second window-sash may be glazed with dark yellow glass. Lamps or candles, provided with yellow screens, may also be used. The dark room should not be too small, as in it several important operations have to be performed; it should be fitted up with shelves for chemicals, a sink and tap, with a good supply of water, several

pails for refuse slops, jugs, and draining stands for the plates. The room should be well ventilated, the door and window being kept open as much as possible when the room is not in use, provided that the weather is not too cold, as an even and tolerably warm temperature is necessary for the proper working of the photographic chemicals. In winter the room must be kept warm; gas or charcoal stoves for this purpose should, however, be avoided. Keep the room as clean and free from dust as possible, and place over the bottles of chemicals small covers of paper, twisted round like an extinguisher, to keep the dust from the necks and stoppers.

The Camera.—This consists of 2 square wooden boxes, the one sliding, like a telescope, within the other. On the front of this is screwed an arrangement of lenses, capable of adjustment; and at the other end is a movable screen of ground glass.

Lens.—There are two descriptions of lenses in use, the single lens which is used for views and photographs of inanimate subjects. This lens requires a longer exposure of the plate than the double lens, but the resulting photograph is very clear in the details. The compound lens used for portraits consists of two pairs of lenses, mounted in a telescopic brass frame, having diaphragms or stops, and provided with a turnscrew to regulate the focus to a nicety, after it has been roughly obtained by adjusting the camera. The interior of the brass tubes holding the lenses must be kept of a dull black colour; should this wear off, a coating of gum-water and lampblack should be applied when cleansing the lenses. It is important to replace the glasses in the lens in exactly the same order and position, after having removed them to clean, which is to be done with a piece of very soft wash-leather. The single lens is composed of an achromatic lens mounted in a brass tube, fixed with diaphragms or stops of various sizes. These diaphragms are simply flat disks of brass, each having in the centre a circular opening, and upon the size of the opening of the diaphragm used, depends the length of exposure necessary, and the sharpness of the resulting picture. The larger the opening of the stop, the shorter will be the time necessary to expose the plate in the camera, but if a stop be used with a smaller opening the picture will be sharper and more distinct in the details. Thus, in working with the view, or single lens, the operator can choose which point is most material for the particular picture he desires. The plate is of course more rapidly affected in proportion to the brilliancy of the light striking upon it. It is sometimes necessary to use a diaphragm with the compound lens, as for instance in photographs of groups, but the openings in these stops are much larger than those used with the single lens. Portrait lenses are usually provided with central diaphragms.

How to arrange the Lenses in a Portrait Combination. — The lenses in a portrait combination are occasionally removed from their cells for the purpose of cleaning. When the lenses are taken out of their cells they may be variously transposed, and thus rendered incapable of producing good pictures. In a portrait combination there are four lenses in all, the so-called front and back lenses being really each formed of a pair. The front ones are always cemented together, and may thus be easily taken for one lens; the back pair are distinct, and are usually separated from each other by a narrow ring. Take the front lens—the pair cemented together—and observe that one surface is considerably curved, and the other almost flat; place the lens in its cell, so that when screwed into the tube the curved side will be to the sitter. The two glasses forming the back lens are very unlike each other; one is thick at the centre and thin at the edge, the other thick at the edge and thin at the centre; put the thin-edged one first into the cell, resting on the least curved side; next put in the ring, and then the thick-edged glass, concave side towards the other lens; fix them in their places with the part provided, and screw the cell in its place. With many per-

trait lenses there is an arrangement whereby the front lens may be used as a landscape lens; to use it for this purpose proceed as follows;—Unscrew the back lens and lay it aside altogether, as it is only required in the double combination; then remove the brass hood before the front lens; next unscrew the front lens, and rescrew it in the place where the back lens was. In doing this the flat surface will be presented to the object. The lens tube may be now put on the camera, and the central stops will be in their proper place for use. As the focus of the front lens, when thus used singly, is much longer than when used in combination with the back lens, the picture it will yield is proportionately larger, but a much smaller stop must be employed than when the lens is used for portraiture. The exposure must be considerably longer than when the double combination lens is used.

Focus.—An object is said to be in focus when its image is clearly and sharply reflected on the ground-glass screen at the back of the camera. The ground glass usually has the sizes of the various plates marked on it, and having decided what size the picture is to be, move the camera to or from the object until its reflexion occupies the proper position, and is of the size required for the picture. The nearer the camera is to the object the larger will be the picture. The next step is one upon which the chief beauty of the photograph depends, the exact adjustment of the focus, so as to bring out quite clearly those points which are considered essential. Having roughly settled the distance, lay the black focussing cloth on the camera, put your head under it, slide the body of the camera gently in or out, until the reflexion is clearly seen on the ground glass. As different portions of an object are necessarily at varying distances from the camera, some will come into focus earlier than others. In portraits, to make the features show distinctly is generally the chief point aimed at. For views no rules can be given, but it is advisable to so place the camera and adjust the focus that the photograph shall not distort or confuse the natural lines of perspective. A little practice is required to adjust the focus satisfactorily, as the image reflected on the ground glass is upside down.

The Glass Frame.—This is always sold with the camera; it consists of a wooden frame, with two shutters, the one opens on hinges, and allows the plate, which has been just removed from the nitrate of silver bath, to be inserted, with its collodionized face placed towards the sliding shutter, which must be kept closed. The frame is provided at the corners with pieces of wire, which prevent the plate from coming in contact with the sliding shutter. Close and fasten the hinged shutter, and the frame is then ready for use. Remove the ground-glass screen, place the glass frame in its place, with the collodion side towards the object, then on raising the sliding shutter the time must be noted in seconds for the desired exposure. Close the sliding shutter, remove the frame to the dark room, and take out the plate by opening the hinged shutter.

Cleaning the Glasses.—The glasses for photography are sold in certain fixed sizes. When new, the sharp edges must be smoothed over with a corrundum file, then carefully wash, rub with a soft rag, finish with chamois leather. When the glasses have been used they are more difficult to clean. If they have been varnished they must be soaked in a solution of common soda, or carbonate of potash, till the varnish peels off. If the carbonate of potash or common soda does not bring off the varnish quickly enough, use a solution of an ounce of nitric acid to every half-pint of water. Apply this to the glasses with a piece of cotton wool, fixed on a handle, so as to avoid contact with the nitric acid, which stains the hands. When the plates have been well covered with any of these solutions, let them stand to drain in a rack, then rub and wash well with a sponge and water. Dry. The side intended for the collodion must next be polished with Tripoli powder and a few drops of spirit of wine, rubbed over with cotton wool,

wipe off the excess of Tripoli, and polish with a dry chamois leather. Place the cleaned plates into a properly grooved box, with all the faces prepared for the collodion turned one way. It is advisable to wash all glasses as soon as possible after use, as by not doing so the varnishes dry on very firmly and are difficult to remove. Waste collodion may be utilized for cleaning glasses; it removes all grease. When glasses have once been cleaned, avoid touching them with the naked hand, as it is sure to leave stain. There are various holders in use; the india-rubber pneumatic is one of the best. Before using a plate dust it carefully with soft silk or a piece of clean old rag. Perfect cleanliness is imperative.

Sizes of Photographic Glasses.—$2\frac{1}{2}$ in. × 2 in., ninth plate; $3\frac{1}{4} \times 2\frac{3}{4}$, sixth; $4\frac{1}{4} \times 3\frac{1}{4}$, quarter, carte de visite; 5 × 4, third; $6\frac{1}{2} \times 4\frac{3}{4}$, half; $8\frac{1}{2} \times 6\frac{1}{2}$, whole. All plates above whole size are denoted by dimensions only, $6\frac{3}{4}$ in. × $3\frac{1}{4}$ in stereoscopic plate. The following are the diameters and focal lengths of lenses suitable for portraits of the usual sizes:—

Diam. of Lens.	Focal length.	Size of picture.
ins.	ins.	ins.
$1\frac{1}{4}$	$3\frac{1}{4}$	$2\frac{1}{2} \times 2$
$2\frac{3}{8}$	5	$4\frac{1}{4} \times 3\frac{1}{4}$
$3\frac{1}{4}$	7	5×4
$2\frac{3}{8}$	7	$6\frac{1}{2} \times 4\frac{3}{4}$
$3\frac{1}{4}$	$9\frac{1}{2}$	$8\frac{1}{2} \times 6\frac{1}{2}$
For groups;—		
$3\frac{1}{4}$	11	9×7
$4\frac{1}{4}$	13	10×8
$4\frac{3}{4}$	15	12×10
$5\frac{1}{4}$	19	15×12
For views;		
$1\frac{3}{4}$	8	6×5
2	10	7×6
$2\frac{3}{8}$	14	9×7
3	16	12×10
4	24	16×12

The dimensions of pictures given are maximum sizes, and to ensure a thoroughly good picture, it is best to use a lens of a larger size than is absolutely necessary. Patent plate glasses are the best for negatives, although flatted crown and sheet glass may be used. Positives are sometimes taken on deep red or purple coloured glass. Whatever kind of glass is chosen, it should be as flat as possible, otherwise it will be difficult to place in the dark slide.

The Argentometer.—This very useful instrument is for ascertaining the strength of the nitrate of silver solution, which becomes weakened to a certain extent, after the immersion of every plate. To use the argentometer, fill the glass jar to within about two inches of the top with the liquid to be tested, and then insert it; the degree on the scale that floats on a level with the surface of the fluid will indicate the number of grains of nitrate of silver contained in each ounce of the solution. There must be sufficient liquid to prevent the argentometer resting on the bottom of the jar. For strengthening a bath to the required standard, it is generally found more convenient to have a stronger prepared bath to add to the weak one, than to add the nitrate of silver direct.

Positives and Negatives.—With the exception of the collodion used, there is very little difference between the chemicals used, or the manipulation required, for the production of a positive or negative. A positive is simply a glass plate coated with a thin film of collodion, rendered sensitive to the light, which receives the image thrown upon it by the lens. The ether and alcohol evaporate, leaving a dry, very thin film of gun-cotton upon the glass. This film constitutes the picture, and may be kept upon the glass, or removed if desired. Positives are now less used than negatives; they are generally kept upon the glass, with a backing of black varnish, and are in fact the result, whereas negatives are only taken as a medium for printing from afterwards.

THE COLLODION PROCESS.—*Plain collodion* is a mixture of alcohol, sulphuric ether, and gun-cotton, which is made suitable for negative photographic purposes by an iodide, or bromide; it is then termed sensitized collodion.

The Spirits of Wine must be perfectly

clear, transparent, and free from any floating impurities. Should it contain any impurities, they must be removed by filtration through a sheet of filtering paper, properly supported in the mouth of the bottle. Should it not run clear and bright the first time, it must again be filtered. The specific gravity of the alcohol should be about ·810, and is not suitable for photography, if stronger than ·819.

Ether.—Care must be taken to procure the sulphuric ether free from foreign substances, and to keep it, and liquids containing it, particularly the collodion, in well-filled and closely-stoppered bottles. The chemical action which takes place when the ether is exposed to the air is very injurious to its photographic utility; it is very volatile, and as the vapour it gives off is explosive when mixed with atmospheric air, care must be taken not to pour it from one vessel to another near a fire or artificial light; as the vapour is heavier than air, it will have a tendency to fall; the artificial light, if used, should therefore be considerably above the vessel from which the ether or collodion is being poured. The specific gravity of the ether may vary from ·720 to ·750; its strength is ascertained by the hydrometer. If the ether obtained is not sufficiently pure for photographic purposes, it must be rectified. Place it in a tall bottle, with about a quarter of its bulk of water, cork the bottle tightly, and shake it for some minutes. When left to settle, the pure ether will float on the water; remove the water by passing a small siphon-pipe, filled with water, through the cork and nearly to the bottom of the liquid in the bottle, holding the thumb over the longer end of the tube. Remove the thumb; the water in the lower part of the bottle will then flow up the siphon, leaving the washed ether in the bottle. This operation should be repeated, and the ether must then be dried and distilled, by placing it in a glass retort, with about a quarter of its bulk of quicklime. Connect a tube to the retort, and arrange a supply of very cold water to fall upon the tube, so as to cool its contents. The end of this tube must be placed over, or into, a bottle; the retort being fixed in a water-bath; a small charcoal fire is lit underneath it, and the heat of the water acting upon the ether causes it to evaporate. In passing along the tube it is condensed and falls into the bottle. The water falling on the condensing tube must be very cold, or the vapour will not be properly condensed. Remove the fire when all the ether is distilled, and clean out the retort at once, as it will be more difficult to clean afterwards. Keep the heat of the fire from the vessel containing the distilled ether, and cork the bottle immediately the operation is completed. A double-stoppered glass bottle is best suited to contain this liquid. As ether boils at a very low temperature, about 96° Fahr., it will commence to evaporate very quickly; and the water in the water-bath should not be allowed to rise in temperature much beyond 110° Fahr., if pure ether is desired. As the first small portion of the ether will probably contain some impurities, that should be rejected.

Gun-Cotton.—Ordinary gun-cotton is used, which is soluble in a mixture of ether and spirits of wine. The proportion of gun-cotton regulates the density of the liquid obtained and materially affects the action of the mixture, when poured on the glass plate.

Weights and Measures used in Photography.—Most chemicals are sold by avoirdupois weight, but all photographic receipts are given either in troy weight, or fluid measure. The pound is the same in both troy and avoirdupois, but in the former it consists of 12 oz., in the latter of 16. Consequently, for an ounce of chemical required by the receipts, more than an ounce must be purchased.

Fluid Measure.—69 minims = 1 dram or 1 ʒ; 8 drams = 1 ounce or, 1 ℥; 20 ounces = 1 pint; 8 pints = 1 gallon. Glass measures graduated for these quantities are used, and wherever fluids are spoken of, this measure is intended.

Collodion Positives.—The articles required are positive collodion, nitrate of silver, developing and fixing solutions, black and crystal varnishes.

Positive Collodion.—Pyrotiline, and iodide of cadmium, or ammonium, 15 grains each; ether, $3\frac{1}{2}$ oz.; alcohol, $1\frac{1}{2}$ oz. Place the two first in a dry bottle, then pour on the spirits of wine, shake the mixture well, then add the ether, shake again, and let it stand for 12 hours. Decant the clear portion into a wide-mouthed bottle, keep well stoppered, and in the dark. Avoid shaking the bottle when about to use the collodion, and never use quite all the bottle contains, as the sediment which will accumulate at the bottom, would spoil the picture. The glass plates used for this process need not be so carefully chosen as for the negative process; they should be as flat as is necessary for them to go into the camera back, but the colour is not material.

Nitrate of Silver Bath.—Re-crystallized nitrate of silver, 5 drams, dissolved in 10 oz. of distilled water. Filter the solution until it is quite clear, then add 3 drops of nitric acid, and 10 drops of collodion. Shake well together and filter. Blue litmus paper should slightly redden in this bath; should it turn very red add a little ammonia or oxide of silver should it not redden at all, add a little acid carefully, drop by drop. It is preferable to have a slight excess of acid.

Developing Solution.—Protosulphate of iron, 2 drams, dissolved in 8 oz. of distilled water, add $2\frac{1}{2}$ drams glacial acetic acid, $2\frac{1}{2}$ drams alcohol, and 5 minims nitric acid. Filter, and pour into a well-stoppered bottle; this solution will keep good for several weeks if not exposed to the air. When about to use this solution, nearly fill a vertical glass bath with it; the plate is immersed in the liquid by means of hooks, called dippers.

Fixing Solution.—50 grains of cyanide of potassium dissolved in 5 oz. of distilled water, that is to say, for every fluid ounce of solution required, mix 10 grains of cyanide of potassium in 1 oz. of distilled water. Filter, and keep in a well-stoppered bottle, which, from the dangerous nature of the solution, should be labelled poison.

Coating the Plate with Collodion.—Hold the plate, which must be perfectly clean and dry, in the left hand, or supported by a pneumatic holder, then pour on very steadily about as much collodion as will half cover the plate. Incline the plate, so that the collodion flows from one corner to the other, until the whole of the plate has been coated; then pour back the superfluous collodion into its bottle, from one of the corners of the plate. Now exclude all but yellow light from the dark room. When the collodion has been on the plate a few seconds it will set and have a dull appearance, the plate must then be immersed in the nitrate of silver bath. Lift the dipper, lay the back of the plate on it, plunge them both steadily into the bath, move the plate about in the solution for a few seconds, then put the cover on the bath. The time the plate must be kept in the nitrate of silver varies with the temperature, from 2 minutes in warm weather, to 10 in cold weather. As soon as the collodion film assumes a creamy appearance, remove the plate from the bath, being cautious to hold it as much as possible by the sides; let it drain on blotting paper, then lay it in the dark slide, collodion side downwards; close the slide. Have a little blotting paper in the dark slide, to absorb any little of the nitrate solution which remains on the plate. Have some of the developing and fixing solutions ready in separate glasses, and clean water handy. The action of the nitrate of silver bath transforms the iodide of cadmium into iodide of silver, which is sensitive to light; the plate is then ready for exposure in the camera. If the plate is placed in the bath before the collodion film has set properly it will peel off, and it will be necessary to filter the nitrate of silver bath to remove it. The film must not be allowed to get too dry, before immersion in the bath, as it will then turn white at once, and will not produce a good photograph. It is important, in first placing the plate in the nitrate of silver bath, to do so steadily and continuously, so as to avoid marking the plate with wavy lines and stains. Cover the bath when not in use.

Exposure.—Having arranged the focus

and finally adjusted the sitter, remove the focus screen from the camera, and put the dark slide in its place, cover the lens with the cap, draw up the shutter, which will turn down on the camera. Up to this point any little movement of the sitter is of no consequence, but having now given the final caution, gently remove the lens-cap, so as not to shake the camera, and note the time in seconds. The time for exposure varies considerably, on a bright day a shorter period suffices than on a dull day, but no certain rules can be laid down, as the nature of the light, the time of day, and the qualities of chemicals employed, are all elements in the calculation—a little practice will soon give an approximation; the usual failing with beginners is too long an exposure. Replace the cap, close the sliding shutter, and take the slide into the dark room.

Developing.—The plate must be immersed in the developing bath, by means of dippers, for about 15 seconds, gently moving it about in the solution. On removing the plate, it must be well washed with clean water; for this purpose a siphon washing bottle is very handy. This is a bottle, through the cork of which two glass tubes are passed. One of these tubes reaches nearly to the bottom of the bottle, the other only just passes through the cork; by blowing through this short tube the water passes up the long one, and is projected with more or less force in the desired direction. After the process of developing and washing, the plate is no longer affected by light, which may therefore be admitted if desired.

Fixing.—The iodide of silver, which gives the creamy appearance to the collodionized plate, must be dissolved, by pouring some of the fixing solution on and off the plate. As soon as those parts of the plate which should represent the black parts of the picture are quite clear, pour off the fixing solution, and wash the plate thoroughly. Dry over a spirit lamp. At this stage examine the plate, it should have a glossy appearance, and the blacks be very pure. If there is a foggy appearance, this may be removed by washing the plate, immediately after the fixing, in a solution composed of 15 grains of iodine, to an ounce of spirits of wine. When the fogging has disappeared, wash away the iodine, use the fixing solution again, wash and dry. If the plate is now satisfactory, varnish the film side with crystal varnish, or a very clear solution of gum arabic; apply in the same manner as the collodion, but run the surplus varnish off the plate quickly, as an excess of varnish injures the effect. The glass side should be coated with black varnish, applied in a smooth layer, by a camel-hair brush. Place the plate in its mount, with a clean glass in front, and close in the back and sides, to prevent dust from getting in.

Crystal Varnish.—Dissolve 1 oz. of white lac in 10 oz. of warm spirits of wine. Let the varnish settle for several weeks, then carefully decant the clear portion into a bottle for use.

Black Varnish for Backing, see p. 72.

General Instructions for Glass Positives.—If the picture is very dark it has not been exposed long enough; if, on the contrary, the shadows are weak, and the dark parts are not dark enough, the plate has been exposed too long. Fogging is a very common and troublesome occurrence; there are many things likely to cause it, and it is sometimes difficult to find which of them it is. Impure air in the rooms, such as from an escape of gas, or from new paint, will sometimes cause it, but usually it arises from some error in the manipulation, or defect in the chemicals. Try the nitrate of silver bath with litmus paper; add a little acid if the paper does not turn slightly red. Examine the window in the dark room, to see that the light admitted is of a sufficiently dark yellow or orange tinge, and see that no light enters at any other place—also make sure that there is no crevice in the camera through which light can pass. Collodion should not be used too soon after it is made. It should be of a golden sherry colour; this may be obtained by adding a little of an old bottle of collodion, which is of a dark colour, or by pouring in a few drops of

tincture of iodine. The principal causes of defects arising from faulty manipulation are, leaving the developing solution too long upon the plate; this results in a bright silvery deposit. When the developing solution has not been properly washed off before fixing, there will be green stains, especially at the edges. If the collodion is allowed to get too dry before being placed in the nitrate of silver bath, there will be transparent spots on the plate. If the developing solution does not flow readily over the plate, and the operator does not perform the developing steadily and carefully, there will be stains or wavy lines on the picture. Any floating dust in the air, or impurities in the solutions used, will cause spots and marks. If a picture, which is brilliant when wet, turns dull on drying, with misty blue shadows, the cause is bad collodion.

Collodion Negatives.—The principal difference between the processes of negative and positive photography is, that the negative plate requires about three times longer exposure than the positive. The plates used may be the same, but certain modifications are necessary in the bath, chemicals, and collodion. The developing solution must be kept on as long as the details of the picture continue to come out, then wash off. When the plate is held up to the light it should present the appearance of a much over-exposed positive, there being very little clear glass, and that only where the shadows are quite black, while those parts which represent the white parts of the picture should be quite opaque. It only happens under the most favourable conditions, in portraiture, that the first developing of the negative renders it sufficiently dense to produce good prints, hence the necessity of the subsequent operation called intensifying; this is a kind of second developing, by which the density is increased to the required degree. The process is as follows:—Put four or five drops of intensifying solution No. 2 into a clean glass; then flood the plate with intensifying solution No. 1, and when it has covered the whole surface, pour it off into the glass containing the No. 2 solution, and shake the glass round so as to mix them, then immediately pour the mixture upon the plate in the same manner as the developer, pouring it off into the glass every few seconds, and holding the negative up to the light each time until it appears sufficiently dense. By careful printing a fairly good proof may be got from an over-exposed negative, but with an under-exposed negative no good result can be obtained. Great care must be taken not to continue the intensifying too long, or a deposit of red fog will take place, and the negative will be spoilt. While the intensifying is proceeding, the liquid gradually assumes a dark claret colour, and if kept on too long will become turbid and cause fogging. The point to which intensifying can be safely carried may be known, after a little experience, by a peculiar change of colour in the high lights of the picture which takes place just before fogging commences. When this change is observed the solution must be quickly washed off. It is important that the intensifier should not be poured on at the same part of the plate each time, or that part will become denser than the rest. The fixing is the same as in the positive process; but a rather longer washing should be given. When dry, the film should be very slightly brushed with a soft camel-hair brush, made for the purpose, to remove any dust or loose particles of silver; the plate must then be warmed until it is as hot as can be borne upon the back of the hand, and the negative varnish poured over the film in the same manner as the collodion; it should not be drained off too rapidly, but allowed to flow slowly over the plate, so as not to leave too thin a coating. If only a few prints are required from the negative, crystal varnish will answer the purpose; but if it is desired to preserve the negative, and to get many prints from it, the crystal varnish will not give sufficient protection, and a spirit varnish must be used, which gives a much harder surface. When the surplus varnish has run off, the plate must

be again gently heated until the varnish is dry. Experience alone will indicate the proper heat to use when applying the varnish; if the plate be not warm enough the varnish will dry dull, and if too hot it will run into streaks and be liable to blister. If any varnish should get upon the wrong side of the glass it can be cleaned off with a little alcohol. As soon as the plate is cold it is ready for printing from.

Faults in Negatives.—In addition to the faults which occur in positives, there are some others to which negatives are liable. If the negative is deficient in density, and has somewhat the appearance of a positive, it is the result of under-exposure, or may be caused by washing off the developer too soon. If the deep shadows, which should be clear glass, are veiled by a grey deposit, and the whole picture is wanting in vigour and contrast, it is caused by over-exposure. Red or brown fog, generally beginning at one corner of the plate, is caused by keeping the intensifier on too long. The film tears and leaves the glass while being washed. This will sometimes occur when the negative has been much intensified. Remedy—longer exposure and less intensifying. The film splits and peels off the plate when dry. Cause—imperfectly cleaned glass or bad collodion. Numerous minute transparent spots, called pinholes, indicate that the bath is out of order. Small crystals which form under and upon the film when dry are from traces of the fixing solution which has not been completely washed off.

Softening of Photographic Pictures.—The likenesses produced by photograph have, in many cases, a harshness which is extremely disagreeable. The camera will tell the truth, but its effects may be toned down so as to give the features something of that softness which is generally imparted by the portrait painter. For this purpose use a lace curtain stretched between the sitter and the camera—the nearer it is to the latter, the more softness it imparts. The grain of a chalk drawing is produced by the threads, and characteristics of the model which would not bear prominence are pleasingly softened down.

PRINTING PROCESS.—The copies taken from the negative are printed upon paper containing a salt which forms chloride of silver by decomposing the nitrate of silver in the sensitizing solution.

Positive Paper.—Specially prepared paper for positives is easily obtained. The size is 22 in. by 17 in.; the weight varies, but should not be less than 24 lbs. to the ream for paper to be albumenized, and for salted paper about 18 lbs. a ream will be heavy enough. Reject any sheets having black spots or blemishes, and those that are uneven in texture. Select the most even side for the chemicals, by examining each sheet in a reflected light, marking the wrong side with a pencil. Always hold the paper by the extreme edge, as a slight stain is sure to be found where the fingers have touched it. For portraits, and most other uses, the paper is albumenized on one side, the resulting print then having a more or less glazed surface, according as to whether or not the albumen has been diluted. When photographs are printed to be afterwards coloured, so-called *plain* paper is used, which gives a dull surface like an engraving. Positive paper, when treated with a solution of nitrate of silver, has the property of rapidly darkening on being exposed to the sunlight; if, therefore, a sheet of it is placed behind a negative and exposed to the light, where the clear portions of the negative allow the light to pass through, the paper will become dark, whilst the dark parts of the negative which obstruct the light will remain white on the positive paper. When the positive print is obtained, it has to be soaked in the fixing solution to remove all the chloride of silver which has not been affected by the light. A careful washing in clean water completes the process of printing.

Albumenized Paper.—There are several well-known papers sold; Rive, which is a French paper, has a high glaze and fine surface; the Saxe, which is more uniform in its texture, is made in Germany;

and that made by Towgood. Positive paper is albumenized by placing it in a mixture composed of the white of eggs and salt. To the white of each moderate-sized egg use 15 grains of common salt reduced to a fine powder; whisk until the albumen is all white froth. Leave this froth in a glazed earthen pan for about 12 hours, by which time most of it has settled into clear albumen; pour the clear portion into a flat porcelain tray. This tray should be somewhat larger than the sheets of paper to be albumenized. Lift the paper up by the ends, and lay it carefully on the albumen, keeping the side marked as inferior uppermost and dry. The paper should be slightly damp before it is thus treated, as it then takes the albumen more regularly, and is not so liable to air-bubbles. The paper must be lifted at each end, and should any air-bubbles appear, brush them off with a card or small brush, replacing the paper in the bath. Wherever the albumen does not come into actual contact with the paper, a white mark will appear in the print. Remove the paper from the bath, and place it to dry on a cardboard frame, or suspended at the corners by clips. Paper glazed with pure albumen acquires too brilliant a glaze for portraits; the albumen may be diluted with from $\frac{1}{4}$ to $\frac{1}{3}$ of its bulk of water. Albumenized paper is not sensitive to light, but absorbs moisture from the atmosphere very rapidly, it should therefore be kept in tin or zinc cases.

Plain Paper. — Albumenized paper may be used as *plain* paper, if instead of sensitizing the glazed side, the plain side is placed in the sensitizing solution. Or place some sheets of Saxe paper in a salting bath of 100 grains each of chloride of barium and chloride of ammonium, and 20 grains of citrate of soda dissolved in 20 oz. of water. Leave the paper in the bath for about 5 minutes, carefully removing all air-bubbles. Then hang the sheets to dry. The pictures produced on this latter paper are not so rich in appearance as those printed on albumenized paper.

Preparing the Paper. — This operation must be performed in the dark room, or it may be done by candlelight, as the prepared paper is not so sensitive as the glass plates. The paper must be cut into pieces of a convenient size, at least a quarter of an inch smaller than the dish which is used to contain the sensitizing nitrate of silver solution. The dish must be perfectly clean, and contain solution at least half an inch deep. The piece of paper is then to be laid gently upon the surface of the solution, with the albumenized, or the selected, side, if plain paper, downwards, and allowed to float upon it without wetting the back; after about 30 seconds the paper should be raised from the solution at one end, and if any air-bubbles appear they must be broken, either by blowing on them or by touching them with a piece of clean blotting paper, and the paper being again laid upon the solution, the other end must be raised and treated in a similar manner. The paper must not be entirely removed from the bath, or it will curl up, and the back come in contact with the prepared side. After floating from 4 to 5 minutes the paper may be removed from the bath, being lifted slowly by one corner with ebonite forceps, and held over the dish until it ceases to drip, when it should be hung up to dry, either by suspending it with a pin through one corner, to the edge of a shelf, or by hanging it by a glass clip to a line. Carefully prevent any of the solution from running on the back of the paper. When the paper is thoroughly dry it should be cut into pieces rather smaller than the negative to be used, and placed in a portfolio or a book. Good paper will keep two or three days after being sensitized if carefully excluded from light and air; but it should always be used as soon as possible, as recently-sensitized paper always yields better prints than that which has been kept for some time. If it is required to keep the sensitized paper for any length of time, it must be placed in an air-tight zinc or tin box, with a little saucer containing some dry crystals of

chloride of calcium. This substance absorbs any moisture there may be in the air in the box, and thus keeps the paper dry.

Printing.—The negative being placed in the printing frame, plain side downwards, the paper is to be laid upon it, with the prepared side in contact with the varnished side of the negative; the back of the frame is then put into its place and the springs closed; if it has screws, these should be tightly screwed down to prevent the paper from shifting; it is then ready to be exposed to the light. With good dense negatives the printing may be conducted in direct sunshine, but weak negatives are best printed from in diffused light. The print must be examined at intervals to see how it proceeds; this is done by raising one side of the hinged back of the frame and turning back the paper from the negative, being careful always to keep the other end of the frame closed, so that the paper may not be displaced, and not allowing any strong light to fall upon the paper while the frame is open. The printing must be allowed to go on until the picture has become rather darker than it is intended ultimately to be, as the subsequent operations of toning and fixing exercise, to a certain extent, a kind of bleaching effect upon it. The back of the printing frame must be quite flat, otherwise the paper will not be in perfect contact with the negative. A passable print may be got from a weak negative, if the exposure to the light be prolonged, but diffused, not direct sunlight, should be used in this case. For vignettes, or other photographs, where white or graduated backgrounds are desired, glasses for the printing frame are used, having yellow borders, which prevent the passage of the pure white rays of light. The resulting print will only be black under the unobscured portions of the glass. The same course may be adopted when the background of a negative is in any way defective. If a recently varnished negative is exposed to the direct action of the sun's rays, it will probably stick to the paper; in such cases it is preferable to use diffused light, or to cover the face of the frame with thin white paper. As a general rule, the printing should proceed until those parts which are to be white assume a slight tint; this will take from ten minutes to a whole day, according to the quality of the negative and the amount of light. When the prints are finished they must be kept in the dark until all that are required the same day are done; the toning and fixing should then be proceeded with as soon as possible, as if delayed many hours the prints will not tone readily, and if kept long not at all.

Toning.—The toning and fixing may be carried on in diffused light, as it is difficult to judge of the colour in toning by artificial light; but not more light than is necessary should be admitted to the room, and the prints shielded from it as much as convenient. If too much light be admitted, the prints will acquire a pink colour while toning. The prints must first be washed for 10 or 15 minutes in at least three changes of rain or distilled water, and then immersed in the toning bath, which should be poured into a glass or porcelain dish; while in the toning bath the prints must be moved about from time to time, so that it may act equally on all parts of them, and only a few prints should be in the bath at one time. After being in the toning bath a few minutes, the red brick colour which the prints usually present after washing will begin to change, and gradually become darker until they are a purple black, at which point they should be removed from the bath and placed in clean water until all are ready. If it is desired that the prints should be of a brown or sepia tone, they must be taken from the bath when they reach the required tint, which will be rather lighter after fixing. If the prints are left too long in the bath they will acquire a cold inky tone, which is very undesirable. Prints on albumenized paper require more gold in the toning bath than those on plain salted paper.

Fixing.—The quantity of fixing solu-

tion required will be in proportion to the number of prints to be fixed; for one dozen, or less, of the ¼-plate size, 5 oz. will be sufficient, and for a larger number the quantity must be proportionally increased. The prints must remain in it for 20 minutes, and during that time must be frequently moved about and separated, and from time to time turned over, so that the solution shall act equally on every part of the paper. If this is not carefully attended to the pictures will soon become discoloured and fade. After 20 minutes' immersion in the fixing bath, the prints must be lifted out, one at a time, held up by one corner for a few seconds to drain, and then plunged into a vessel of clean water. The hyposulphite solution should be used slightly warm.

Washing.—The object of this process is to secure the stability of the picture by removing all traces of the fixing solution with which the paper is saturated. One of the chief causes of the fading of prints is insufficient washing. The water in which the prints are placed must be changed at least six times, at intervals of about an hour, and each time the water is changed the prints should be taken out separately and drained before being put into the fresh water. In the last change they may remain all night. The more capacious the vessel used in this process, and the oftener the water is changed, the more permanent the prints will be. An earthenware pan will be found convenient. Wooden or metallic vessels must be carefully avoided. A convenient way of washing prints is to place them in a large pie-dish or a photographic dish, and place this in a sink, under a tap turned on only sufficiently to run a small stream continuously, which should run in at the higher end of the dish, this being slightly tilted. The prints will thus be kept in continual motion by the water, and in one night be perfectly washed. Another method is to pin the prints by their edges in a row to a long slip of wood, such as a lath, and set them afloat in a water cistern for 12 hours.

Mounting.—When the prints have been thoroughly washed and drained they should be laid between sheets of clean blotting paper, to absorb the superfluous water, and afterwards dried. As they usually curl up when dry, they may be flattened by drawing the back of the paper over any blunt-edged instrument, such as a paper knife, or the back may be pressed with a warm flat-iron; they are next to be cut to the proper size by means of a glass cutting shape and a sharp knife, and then mounted on cards with a newly-made cold paste of dextrine or starch. The appearance of the finished prints is greatly improved by having them rolled.

Good photographers usually cover small defects in likenesses by touching them with a small brush dipped in colour the same tone as the print.

To Varnish Cartes de Visite.—The mounted photograph must first be sized with a warm solution of 10 grains of gelatine dissolved in 1 oz. of water. Hot-press, or burnish with a burnisher. Then apply crystal enamel, by means of a small piece of cotton wool saturated with the enamel, and wrapped in a perfectly clean piece of white calico rag, slightly moistened with linseed oil. Gently rub this over the picture with a circular motion, until it becomes brilliant, then finish by applying a little spirits of wine, and lastly linseed oil, in the same manner.

Crystal Enamel.—Dissolve 1 oz. of white lac in 10 oz. of warm alcohol. Let the mixture stand for some weeks, then decant the clear portion for use.

Defects in Paper Prints.—A marbled appearance on the surface of the paper indicates that it has been removed from the sensitizing solution too soon, or else that the solution is too weak. As the strength of the solution is decreased each time it is used, it should be tested occasionally with the argentometer, and sufficient nitrate of silver added to bring it to its original strength of 60 grains to the ounce. White spots are the result of air-bubbles which have not been detected and dispersed while the paper was being sensitized. Red spots

which will not change colour in the toning bath are caused by touching the face of the print with the finger, which has left a greasy impression on the albumen. If the prints are weak and slaty in colour, either the negative is in fault, the paper is bad, or the sensitizing solution is too weak. If the prints become yellow or spotted after they are finished it is because the fixing and washing processes have not been properly carried out.

Plain Collodion.—Mix in a bottle, gun-cotton, 450 grains; ether, 25 oz.; spirits of wine, 7 oz. Shake these well together, and leave to settle for several days. If well corked, this mixture may be kept for any length of time.

Sensitized Collodion.—Add to 1 oz. of the plain collodion, 6 drams spirits of wine, 1¾ oz. ether, and 3 drams of iodide of bromide solution. Shake the bottle well; the mixture is then ready, but is improved by being kept 4 or 5 hours before using. In hot weather a little more alcohol and less ether, in very cold weather more ether and less alcohol must be used. As sensitized collodion does not preserve its qualities well, it is better not to mix the plain collodion, and the iodide and bromide solution until shortly before required for use.

Iodide and Bromide Solution.—Iodide of cadmium, 154 grains; bromide of cadmium, 54 grains; spirits of wine, 3½ oz. Pound the iodide and bromide very fine in a mortar, adding the spirits gradually; when the iodide and bromide are dissolved, pass the solution through a filter paper into a bottle. This solution will not deteriorate if kept in a closely-stoppered bottle.

Iodide of Cadmium.—Put 4 oz. of iodine into a pint of water, add 2 oz. of cadmium, broken small. Warm gradually, and keep the water at about 190° Fahr. for several hours; when the liquid becomes colourless, let it cool, and then filter. The remaining cadmium may be again used. Evaporate the solution down to crystals, which must be pounded in a mortar to a fine powder. Keep in a stoppered bottle.

Bromide of Cadmium.—Pour 3 oz. of bromide into 1 pint of water, then add 2 oz. cadmium, broken small; put into a stoppered flask. Let the ingredients stand for several days, shaking the flask occasionally. When the solution becomes discoloured, filter and evaporate, reduce to powder, and keep in a stoppered bottle.

Iodized Collodion may be made at one operation; it should be kept 2 days before being used, but is less reliable, if kept for any length of time, than is sensitized collodion which has been made as above described, as the iodide will decompose the other ingredients. Place 16 grains of gun-cotton in a bottle, add 18 grains of iodide of cadmium in powder, and 6 grains of bromide of cadmium in powder, and 1½ oz. of spirits of wine, sp. gr. ·805. Shake the bottle until the iodide and bromide are dissolved, then add 3 oz. ether, sp. gr. ·720, and shake until the cotton is dissolved. After settling for 24 hours decant the clear portion into small well-stoppered bottles.

Nitrate of Silver Bath for Negatives.—Recrystallized nitrate of silver, ½ oz.; distilled water, 7 oz.; collodion, 7 drops. Shake well together until the crystals have dissolved, then filter. The purity of the negative bath is a matter of great importance; none but the best recrystallized nitrate of silver must be used, and the introduction of foreign matter of every kind must be carefully guarded against. When the bath gets out of order, which will not occur very soon if it is properly used, it should be diluted with an equal bulk of distilled water, and exposed to the sun for a few days in a white glass bottle, then filtered, and sufficient nitrate of silver added to restore the strength to 35 grains an ounce, as indicated by the argentometer.

Developing Solution for Negatives.—Protosulphate of iron, 75 grains; glacial acetic acid, 2 drams; alcohol, 2 drams; distilled water, 5 oz. Dissolve the crystals in the water, then add the acid and alcohol, and filter. This solution will keep good for several weeks. In hot weather a little more acetic acid

may be added, and if it does not flow readily the alcohol may be increased.

Intensifying Solution, No. 1.—Pyrogallic acid, 10 grains; citric acid, 10 grains; distilled water, 5 oz. This solution will not keep long; when it becomes brown it should be thrown away. *No.* 2.—Recrystallized nitrate of silver, 40 grains; distilled water, 1 oz. Dissolve and filter. This solution will keep for any length of time.

Another Intensifying Bath.—A saturated solution of bichloride of mercury in water. Powder the bichloride of mercury, place in a bottle, add the water, and shake. Place the negative plate in a bath of the solution, remove when the film assumes a milky white appearance, wash, and then plunge in a solution of 1 oz. of liquid ammonia to 10 oz. of water, which immediately darkens the plate. Remove the plate, wash, and place to dry. This mode of intensifying may be regulated by leaving the plate in the bichloride of mercury a shorter time, when it will require a weaker ammonia bath than that above given.

Fixing Solution for Negatives.—Hyposulphite of soda, 5 oz.; distilled water, 5 oz. Dissolve and filter. This solution will keep good for many months.

Sensitizing Solution for Paper.—Nitrate of silver, 5 drams; distilled water, 5 oz.; nitric acid, 2 drops; kaolin, 1 oz. Dissolve the nitrate of silver in the water, and then add the acid and kaolin; the kaolin will not dissolve, its use being to prevent the solution becoming discoloured after using. This solution will not require filtering; it must be allowed to settle until quite clear, and when required for use decanted carefully, leaving the kaolin in the bottle; after using, it should be returned to the bottle and well shaken with the kaolin, which will carry down all the colouring matter as it subsides. As this solution rapidly becomes weaker by using, it should be tested with the argentometer occasionally, and sufficient nitrate of silver added to restore it to its proper strength, which is 60 grains to the ounce.

Another Negative Collodion.—Ether, ½ oz.; alcohol, ½ oz.; cotton, 7 grains; bromide of cadmium, ½ grain; bromide of ammonium, 1½ grain; iodide of cadmium, 2½ grains; iodide of calcium, 1 grain; iodide of potassium, 1 grain; iodide of ammonium, 1 grain. For intensifying, flood with chloride of gold, 1 grain; water, 15 oz.; then wash and flood with pyrogallic acid, 2 grains; water, 3 oz.

Toning Baths.—1. Chloride of gold, 4 grains; acetate of soda, ¼ oz.; distilled water, 10 oz. Dissolve and filter. In purchasing chloride of gold in small quantities it will be found best to have it in solution containing 4 grains to each ounce of water. This solution improves by keeping, but will require a little chloride of gold added to it occasionally. A black deposit will form in it after using, which should be removed by filtering.

2. To produce black to bright sepia tones, according to length of immersion;—Take carbonate of soda sufficient to cover a threepenny-piece; dissolve it in a teaspoonful of cold water in a cup; add 2 grains chloride of gold; then add 3 oz. of boiling water; use in 15 minutes. After toning, pour it into a stock bottle, adding a particle of acetate of soda to give it keeping qualities. The next batch to tone, commencing in same manner, but using half the above quantities. Add it to the stock, and tone immediately, and so keep on, omitting the acetate of soda, which should be used but once in twenty times. It is well known that one formula will suit one paper but not another. This will suit Hart's albumenized paper.

Fixing Solution for Paper Prints.—Hyposulphite of soda, 8 oz.; distilled water, 1 pint. This solution must only be used once, as it is useless afterwards.

Stopping-out Negatives.—Small round transparent spots are frequently found on glass negatives, which if not stopped-out, occasion corresponding black spots on the print. Lay the plate on a slab of glass, having either direct or reflected light shining up through it. Then cover the spots with a mixture com-

posed of 10 parts ivory black, 2 parts saturated solution gum arabic, 2 parts white honey, 1 part sugar-candy; well mix, and apply with a fine camel-hair brush. Should the spots on the negative be black, or opaque, white spots will be formed on the print, these are easily tinted with a little water colour, to match the other portions of the print, it is seldom necessary therefore to alter the negative on this account.

Albumen Varnish for Negatives.—Remove the cords and yolks from several eggs, whisk the albumen to a froth, let it settle. Decant the clear portion, add half its bulk of distilled water, and one dram of liquid ammonia for each pint of the varnish. After having washed the plate, and whilst the film is still damp, apply the varnish in the same way that collodion is poured on. Repeat the operation, then place the plate to dry, with the film side protected from dust.

Amber Varnish for Negatives.—Fill three-fourths of a bottle with small pieces of yellow amber, pour upon it a mixture of equal parts of chloroform and ether, in sufficient quantity to just cover the amber. After standing several days filter the liquid; use closely-stoppered bottles. Pour the varnish over the collodion film of the negative, drain and let dry. This varnish is more easily applied than the crystal varnish, as it does not require artificial heat to dry it, but it does not give such a firm varnish to the negatives. The amber which remains in the bottle, after the liquid varnish has been poured off, may be used again and again for the same purpose.

VIEWS AND LANDSCAPES.—In taking views, the process is exactly the same as in the case of portraits, except that the exposure is very much less. Views can be taken with the ordinary portrait lens, although distant objects are generally produced by it on too small a scale; this difficulty may be overcome by removing the back pair of lenses from the tube and using the front combination only, provided the camera will open to a sufficient length for focussing.

COPYING PICTURES.—Pictures and engravings can be easily reproduced by photography. If framed the glass must be removed, or the reflected light will interfere with the image formed by the lens. The picture must be placed in a good light, and the front of the camera must be parallel with it, or the copy will be distorted. A small stop should be used, and the negative rather under-exposed than otherwise. Copies of photographs, except on a reduced scale, are seldom as satisfactory as the original, for the grain of the paper gives a peculiar mottled effect to the picture.

Toning Bath.—To produce rich purple tones;—30 grains acetate of soda, 10 oz. water, 5 grains carbonate of soda. This to be mixed some hours before wanted, and chloride of gold sufficient to tone the prints in hand added just before required for use. The bath works quickly hot and slowly when cold; the solution may be used over and over again.

Toning and Fixing in one Bath.—The following formula yields a fine, rich, warm, black tone, with somewhat rosy half. Water, 2 oz.; sulphocyanide of ammonium, 50 grains; hyposulphite of soda, 240 grains; acetate of soda, 15 grains; chloride of gold, 1 grain. Dissolve the gold in a small quantity of water, and add it to the other solution. The bath may be used immediately after preparing. The prints are not washed before putting them into the bath. They become yellow at first, but afterwards recover their force. The toning and fixing takes about 10 or 15 minutes, but can be continued for some hours. The acetate may be substituted by the benzoate, the phosphate, borate, citrate, or any other such salt, for the purpose of modifying the tint desired.

To quickly obtain Positive Prints.—In dull weather it is sometimes necessary to expose the paper for a whole day before a positive print can be obtained, and although albumenized paper prints more rapidly than plain paper, the time necessary is still often inconveniently long. This trouble may be avoided by the following process;—

Cut plain paper to the required size, let it float on the surface of a solution composed of 10 grains of iodide of potassium dissolved in every 3½ oz. of the water required for the bath. When it has remained in this solution about one minute, remove and drain. Then float it for about one minute, in the dark, on a sensitizing bath composed of 3½ oz. of water, 30 grains of fused nitrate of silver, and 300 grains of glacial acetic acid. Withdraw, drain, and press carefully between several folds of pure white blotting paper. Then place the paper, still slightly damp, upon the negative. The exposure, in diffused light, necessary in this case, will only be from about 5 to 15 seconds. Remove the paper from the negative, and place it on a glass plate, with the sensitized side of the paper uppermost. Then spread some of the following developing solution over it, with a fine soft brush;—15 grains of gallic acid, dissolved in 35 oz. of warm water, 3½ drams glacial acetic acid; mix and filter. As soon as the picture is sufficiently developed, place it in water, to stop the action of the developing solution. Tone in a weak solution of chloride of gold, with a small quantity of carbonate of soda. Then soak for several hours in plenty of clean water.

Thomas Sutton's Wet Collodion Process.—The old process has one weak point, which renders it unfit for long exposures to dark subjects, such as interiors,—the free nitrate which must be left upon the film in order to render it sensitive gradually attacks the iodide of silver, and combines with it to form iodo-nitrate. From this Sutton's wet collodion process is free, whilst all the good qualities of the old method are retained. The process consists in using a bromized collodion containing no iodide, exciting the plate in a nitrate bath, washing off the free nitrate, pouring an organifier over the film, exposing it wet in the camera, and developing it by the alkaline method, after which it may be fixed, washed, and varnished in the usual way. After making the plate visibly clean, and wiping it dry, put it upon a wooden French plate-holder with a screw, and pour upon it a little tripoli made into a cream with a mixture of equal parts of alcohol and ammonia. After rubbing this all over the plate with a tuft of cotton wool, polish it with a clean dry tuft of the same wool, and carefully wipe the edges. The mere cleaning of the plate may be done with nitric acid or aqua regia, followed by copious washing. The collodion film adheres best to a plate which has been finally polished with tripoli rendered alkaline in the manner described. It is a good plan to use a coating fluid made by dissolving india-rubber in any of its solvents, such as mineral naphtha, chloroform, or kerosolene. Three grains of india-rubber paste dissolved in a dram of chloroform, add kerosolene to make up the ounce. The solution is then left to settle, and the upper part is carefully decanted for use. It is poured over the dry polished plate in the same way as collodion; the film sets in a minute or two, and then the collodion may be poured on. A slight opalescence in the rubber film is of no consequence, as this does not show after the collodion has been applied to it. The advantage of the coating fluid is, that it fills up holes and scratches in the plate, and renders them comparatively harmless. It is a great safeguard against splitting and blistering of the film in the various operations, where these are protracted. Albumen must not be used as a coating fluid in this process, because it would injure the bath. For the collodion any good pyroxyline will do; it need not be especially powdery. The collodion should not be anhydrous. The ether should be absolute, but the alcohol may lie between 808 sp. gr. and 812 sp. gr., according to the proportion in which it is added. In summer, and particularly in a hot climate, the alcohol should be in excess of the ether; but in winter there may be 5 parts of ether to 3 of alcohol. The more alcohol, the stronger it should be. When alcohol 805 sp. gr. is used, with the thermometer at 90° Fahr., there may be three times as much alcohol as ether in the collo-

dion, but the film is then very subject to nibs. The collodion should be bromized with bromide of cadmium, because that is so soluble in alcohol that a larger dose of it may be introduced with facility. There are two kinds of cadmium bromide—one anhydrous, the other containing four equivalents of water. The latter is preferable, as being the least trouble to dissolve, but the water may be expelled by heating the crystals in a capsule. The quantity of bromide to an ounce of collodion is a matter of some importance, because the sensitiveness of the film, and the density of the negative, depend upon there being plenty of bromide of silver upon the plate. Twelve grains of hydrated cadmium bromide to an ounce of collodion will be found a good proportion. Less than this is liable to give thin negatives, which require to be intensified with silver. Films thinly bromized are also less sensitive than those of the full density. According to Sutton a good test for the mechanical quality of collodion is to pour a little upon a glass plate, and examine the film a few minutes after, when it has become perfectly dry. If it appears opalescent, or if it shows structure, the collodion is bad, and useless for any purpose. The best solvents to employ are pure alcohol, and methylated ether which has been redistilled with quick lime. The fresher they are, the better apparently. The bromized collodion will keep indefinitely; but when great sensitiveness is required it is better to use it fresh. The nitrate bath should not be less than 80 grains to the ounce. It should be made with pure neutral nitrate of silver. A minim of nitric acid may then be added to every 5 oz. of solution, in order to neutralize any free oxide of silver which it may contain. This bath is costly in the first instance, but as there is subsequently no waste of silver it is economical in the long run. No silver is used in developing, and all that clings to the back and front of the plate on its removal from the bath goes into the washing waters, and is eventually restored to the bath without having to be reduced. It is immaterial how long the plate remains in the bath, provided it remains long enough, about 3 minutes in summer, and 5 minutes in winter. Too short an immersion in the bath is proved by the film not possessing its maximum of sensitiveness, and the negative being bright, dense, and hard. The appearance of the film is a sure guide to the full time of immersion in the bath; but as it matters not how much the proper time is exceeded, no mistake need be made in this matter. This strong bath does not produce pinholes. These proceed in general from particles of dust which stick to the film. The film is so thoroughly washed in this process that any crystals of bromo-nitrate which might adhere to it would be decomposed and removed by the washing water. This immunity from pinholes produced by double salts is one of the advantages of Sutton's method. The nitrate bath does not seem to get out of order so quickly in this as in the common wet process. It does not require treatment with bicarbonate of soda, and sunning every now and then, to keep it in good working condition. It is necessary, however, to keep it always up to the right strength. The vessel in which it is kept should be left open in order that the ether and alcohol may evaporate. There should be a series of at least three vertical washing baths, placed side by side, and filled with distilled or clean rain water. The plate, on its removal from the nitrate bath, is to be placed in each of these for 2 or 3 minutes, and then transferred to a large pan of rain water, with a lid, in which it may remain until required for use. Washing bath No. 1 soon acquires a quantity of silver nitrate, and this solution should be used instead of water for making fresh nitrate bath to replenish with. The gap thus made in No. 1 must be filled up by water from No 2, and so on. By proceeding thus, not a single grain of nitrate of silver is wasted, but the whole of it is utilized in forming the sensitive film of bromide upon the plate. It is absolutely necessary to remove all the free nitrate from the

film, for, if any should remain, it would at once be darkened by the contact of the alkaline developer. Five minutes in the three baths is the least time that can with safety be allowed for the removal of the free nitrate. A plate which has been left for 30 hours in the nitrate bath may afterwards be left for 3 days in the pan of rain water, and still give a bright and beautiful negative. Portrait photographers will find it a great advantage to be able thus to prepare their plates beforehand, ready for use at a moment's notice when a sitter arrives.

The Organifier must be applied after the removal of the plate from the rain-water pan. It is only necessary first to give it a rinse with a little clean rain or distilled water. Spring water should on no account be employed for rinsing the plate. For the usual organifier employ albumen, 1 part; distilled water, from 3 to 6 parts. For the highest attainable degree of sensitiveness use Nelson's neutral gelatine, 3 grains; sub-carbonate of soda, 1 grain; distilled water, 1 oz. The albumen and water should be beaten up together and then allowed to settle. The clear liquid should be filtered through a piece of cambric folded twice. The gelatine should be dissolved by heat, and the solution filtered after the alkali is added. Neither of the above organifiers keep well. They ferment and become putrid in a few days. It is important to use pure neutral gelatine. When the plate is not to be exposed immediately after it is organified, but has to be kept for some hours before the exposure or development, one-half of the water which the organifier contains should be replaced by pure glycerine. This will keep the film moist and in good condition for at least a day and a night. By the use of glycerine in the organifier a landscape photographer may prepare his plates in the morning, expose them during the day, and develop them at night. Such plates cannot well be prepared in a tent, but they may be carried for a whole summer's day ready prepared, and be developed in a light and portable tent soon after their exposure. This method is less troublesome than the preparation of dry plates. The plates are much more sensitive than common wet ones; yet the exposure is by no means a critical matter; certainly not more so than in the common wet process. It is always well to put a sheet of damp red blotting paper at the back of the plate, in order to prevent blurring from internal reflection. There are two methods of development—one a quick, the other a slow one. The quick method takes about 2 minutes, the slow method about 5. The plate is then washed and fixed, no intensification with silver being in general required, or, if required, being done after fixing. The following is the slow method of development, the quick method only differing from it in doubling the strength of the solution. Make a solution of bromide of potassium 5 grains to the oz.; and a solution of ammonia fortis and water, equal parts. Keep these in 1-oz. wide-mouthed bottles, each of which is provided with a dropping tube. Now take a glass measure, and put it into 2 minims of potassium bromide solution, 1 oz. of water, spring water will do, and 3 grains of pyrogallic acid. This done, proceed quickly with what follows, for the developer should be used fresh. Wash the organifier off the plate with some clean water, then add a minim of the ammonia solution to the developer, and pour it over the plate in the usual way with one sweep, and not too violently upon any particular spot, or that will begin to develop before the rest. Keep the developer flowing backwards and forwards upon the plate for about a minute, up to all the edges and corners, and then the image may begin to show of a pale red tint. Now add another drop of bromide of potassium solution and another of ammonia. Repeat this from time to time until the negative is dense enough; but although ammonia intensifies it and brings out the details, be extremely careful not to add a drop too much, or the image may be suddenly veiled and the picture be irreparably lost. The development, whether slow or quick, is always gradual and under command, and the image does not

flash out as with iron in the common process, but by degrees, as when pyrogallic acid is used. The film must now be washed, and fixed with weak hyposulphite of soda, and then be washed thoroughly again. It will then be seen that the image is of a yellow colour, and although thin, possibly, will yield a vigorous print.

The Varnish should be made with lac only, and should contain neither sandarac nor benzoin. Purified seed lac is the best. Mix alcohol, 820 sp. gr., 1 oz.; lac, 50 grains. Dissolve without heat, and decant from the sediment. This varnish may be partially decolourized by mixing animal charcoal with it. Do not heat the plate much before varnishing, but heat it as much as desired afterwards. The negative is now finished, and may be kept in a paper envelope.

For the conversion of a Negative into a Positive, a full exposure should be given, in order that the light may act entirely through the film in the sky and other spaces which are to be eventually clear glass; and the development should be pushed to the very verge of fog. The film should now be washed, and instead of fixing it with hypo. some strong nitric acid should be poured over it. This will quickly dissolve all the blacks, leaving them bare glass, whilst the half-tones and real shadows of the view will be represented by the pale yellow bromide of silver in layers of different thickness, so as to produce a beautiful kind of positive transparency. In order to blacken this, the bromide image must be converted into one composed of metallic silver. This is effected by removing the bromine from the bromide of silver by means of redevelopment. The best plan is, after washing off the nitric acid very thoroughly, to pour some alkaline developer over the image and expose it to the light; then add more ammonia to the developer, and thus blacken the image as much as you can. Of course no fixing with hypo. is required. These positives are very perfect in their details, and although of an ugly colour, are suitable for the multiplication of negatives by copying, or for producing an enlarged negative, without having recourse to a print. The only trouble in this operation consists in the high lights not coming out clear glass, as they ought to do under treatment with the nitric acid. To make a good positive the sky of the negative should look very nearly as black on the back as on the face of the film. For Sutton's process there must not be too much light in the operating room or tent, and the colour of the light should be orange, and not yellow. The main difficulty in the process is to get the negatives to intensify sufficiently without silver; but, when all else is right, feebleness can only proceed from a deficiency of bromide of silver in the film. With 12 grains of cadmium bromide to the ounce of collodion, and an 80-grain bath, this difficulty ought never to occur, unless the plate is much under-exposed. For common subjects, where great sensitiveness is not required, the quantity of bromide may be reduced to 8 grains, and 2 grains of chloride of cadmium may be added. The negatives will then be very bright and dense. This is recommended for copying paintings, engravings, and maps. Where very thin, delicate negatives are required, full of harmony and detail, use less bromide in the collodion, and give a longer exposure. In working by candlelight, inclose the candle within a screen made of orange-coloured paper, or of Solomon's orange-coloured oiled muslin.

Dr. Ryley's Modified Collodio-Albumen Process.—The plate has to be sensitized as usual, and thoroughly well washed. Coat with the following solution;—Albumen, 1 oz.; water, 2 oz.; ammonia, 30 minims. Beat well up to a froth, allow it to settle, and filter before use. Pour sufficient of this over the plate to cover it; let it flow backwards and forwards to soak into the film. Pour the solution away, and thoroughly wash the plate, the last rinsing being with distilled water. Let the plate dry. When perfectly dry, moisten the plate with distilled water, and pour over the following;—Gallic acid, 2 grains; water, 1 oz. Filter the solution before using. Pour it on and off the plate to well per-

meate the film, then set the plate up to drain, and dry without washing off the gallic acid solution. When surface-dry, finish by the heat of a dull fire. These plates retain their sensitiveness well. The development of the plates may be by the plain or alkaline pyro method. The peculiarity of this process consists in the final wash of gallic acid after the prepared plate has dried from its albuminous coating.

England's Modified Collodio-Albumen Process.—The plate having been coated with bromo-iodized collodion, and sensitized as usual in a 40-grain bath, should be washed till all greasy lines are removed; next float over the film an albuminous solution formed of one white of egg to 3 oz. of water and 2 drops of ammonia. These require to be well beaten together and filtered. When this solution has been poured over the film backwards and forwards to well permeate it, the plate has to be washed again under a gentle stream, ending with a little distilled water. The plate has now to be resensitized by flowing off and on a 30-grain solution of nitrate of silver, slightly acidulated with acetic acid. Again wash well and dry. This latter sensitizing gives increased vigour and sensitiveness to the plate. The exposure should be about three times longer than for a wet plate. Either plain or alkaline pyro may be used to develop, and intensify with acid silver and pyro.

Collodio-Bromide Process. — The peculiarity of this process mainly consists in dispensing with the nitrate bath and using a collodion which contains the sensitive salt. The greatest care is required in preparing the collodion. It is composed of — Pyroxyline, 6 grains; ether, ½ oz.; alcohol, ½ oz.; bromide of cadmium, 6 grains; bromide of ammonium, 2 grains. Mix as much of this as may be required, as it will keep indefinitely. It should stand a week before being employed. When ready for use, pound nitrate of silver to the finest possible powder in a glass mortar, and add 11 grains to every ounce of the above bromized collodion. Add gradually, and shake so as to get it well combined. Allow this sensitized collodion to rest for 3 hours before use. The mixing must be made in a non-actinic light, and the collodion must be kept in the dark. In this state the collodion will not keep for many days, therefore not much more should be sensitized than will be speedily required. Varnish the edges of the glasses a quarter of an inch with india-rubber and benzole varnish, and coat the plate with the sensitive collodion. Allow it to set well, and immerse in a dish of water till all greasiness disappears; next put the plate in a dish containing a solution of tanning, 15 grains to the ounce of water, or use the following solution;—Tannin, 10 grains; gallic acid, 3 grains; grape sugar, 5 grains; alcohol, 10 minims; water, 1 oz. Prepare as follows;—Dissolve the gallic acid first in the water, using heat; next add the tannin, then the grape sugar. Filter, and, when cold, add the alcohol. Allow the plate to remain in this solution 3 minutes. Let the plate dry evenly and quickly in any convenient manner, and it is ready for use. Expose three times the time required for a wet plate. Use the alkaline pyro developer, adopting all the precautions described in the use of the bromide of potassium. If there be any difficulty in obtaining the ultimate intensity, the acid pyro and silver may be used. The fixing may be done with cyanide, as it counteracts any splitting of the film on drying. When experience is gained in working the process, the quantity of nitrate of silver in the collodion may be increased to 12 or even 13 grains, accompanied with increased sensitiveness in the plate. A very simple method of using up the residues of sensitized collodion is to add an equal quantity of plain bromized collodion, reserving the necessary addition of nitrate of silver until a few hours before it is required for using the next time. This prevents deterioration and loss of material.

The Autotype Process, *or Carbon Printing*.—Johnson's process is adapted to supply the place of albumenized paper and silver, gold, and hypo. solu-

tions; the manipulations are more simple than silver printing, and less skill is required for producing prints by this method than by the usual silver one. The most troublesome portion of any carbon process is the preparation of the tissue, that is, the sheet consisting of the layer of gelatine and carbon or pigment. This carbon tissue consists of a layer of gelatine containing the carbon or other permanent pigment spread on paper. As sold it is not sensitive to light, but requires the action of a solution of bichromate of potash to render it sensitive. So far the process resembles the silver printing one—the tissue corresponding with albumenized paper, the bichromate-sensitizing solution with the silver one. When the paper is dry, the coloured surface is placed in contact with the negative and exposed to light; the exposure should be about one-third the time required for silver printing. The pigmented paper is prepared in long rolls, so that much larger sheets can be obtained than of albumenized paper. It should be cut into convenient sized sheets for sensitizing. A solution, 20 grains to the ounce, of bichromate of potash is provided in a flat dish. The sheets may be placed in the solution one at a time until all are immersed. Each should be turned over to see that no air-bubbles form. They must remain in for one minute, but may stay longer without injury. They should then be taken out, and hung to dry. This sensitizing and drying must be done in chemical darkness, like sensitizing silvered paper; more caution must, however, be taken, as the carbon paper is so much more sensitive. When the paper is dry it must be placed in contact with the negative to be printed. It is advisable for carbon printers to classify their negatives. Let those negatives that print the quickest be called No. 1; those that require longer printing, No. 2; and those still denser, No. 3. By the use of an actinometer the amount of printing given in a certain time can be measured. This simple little apparatus consists of a round japanned tin box, with a slot in the lid about $\frac{1}{4}$ of an inch wide and an inch long, like a money-box. Inside the box is a strip of Carrier's sensitized albumenized paper, about $\frac{1}{2}$ an inch wide, coiled up in a roll. The lid of the box is painted a chocolate colour, like the tint that sensitized albumenized paper quickly takes when exposed to the light. By a simple means a portion of this paper is pulled out of the box, and in doing so a portion is exposed to light through the slot in the lid, the rest of the strip being screened from light. The paper when exposed begins to darken, and presently arrives at the same tint as that surrounding it on the lid of the box. Let us suppose a negative to have sensitized pigmented paper placed under it, and the actinometer to have a piece of the white sensitive silver exposed through the slot, then let the actinometer and the negative be both exposed simultaneously to the same light; by the time the light has darkened the silver paper to the standard tint, the actinometer and the negative will both be said to have received one tint, that is, they will both have received that amount of action from the light necessary to produce on the silvered paper that particular tint. In the first instance each negative, or each class of negative, will have to be tested by the actinometer, how many tints have to be darkened before the carbon print is made, and the negatives may then be marked accordingly. When a negative has been once tried and marked the number of tints it requires, no mistakes will be made afterwards as to the exposure that will be required. The next operation is to attach the print to a temporary support during the development, or removal of the unacted-on pigmented gelatine. Plain gelatine is not sensitive to light, but is easily soluble in hot water. The bichromate of potash makes it sensitive to light, and the change effected in the gelatine by light renders it insoluble in hot water, but the rest of the gelatine still remains soluble. The insoluble portion constitutes the picture, and it is necessary to dissolve everything but that which light has rendered insoluble. The print has

to be attached for this purpose to a temporary support. Almost any substance impermeable by water will answer, but some substances are more convenient than others, such as the surface of ground opal glass, or zinc plates that have a finely-ground surface. To facilitate the removal of the print from this slightly-roughened surface, rub the support over with a dilute solution of resin and wax in turpentine, using a soft rag, and leaving only a very thin film of the solution on the surface. The pigment print is first immersed in cold water, gelatine side downwards; the print at first curls inwards as the paper on the back expands with the water, but in a few seconds it flattens and shows signs of curling outwards; at this juncture take it out, and previously wetting the glass or zinc that you are going to develop it on, lay it on gelatine side downwards, and with an india-rubber scraper, or squeegee, press the print in close contact to the support to expel the water. Sweep the squeegee backwards and forwards once or twice to get rid of all moisture that can be driven out. Allow the print to remain thus for a few minutes, and if you have other prints ready to go on with, you may serve them all the same until you have several ready. This pressure ensures the perfect adhesion of the print to the surface of the support through all the subsequent hot and cold water washings. The glass or zinc with the print thus firmly attached by atmospheric pressure may now be immersed in hot water at say 100° Fahr. Let it remain for a few minutes. When the coloured gelatine begins to show itself oozing from the edge of the paper, try one of the corners of the paper if it will lift easily; if so, lift it slowly and steadily from the support, and it will come off, bringing with it a great deal of the unaltered gelatine. If it does not lift off easily, allow it to remain until it will do so. On no account force it up. The time it takes for the paper to come freely away depends on the temperature of the water it is immersed in; the water need not be hotter than the hands can bear. When the paper is removed the rest of the unaltered gelatine will speedily flow away, and the picture will gradually emerge from the dirty mass that envelops it. Allow it to remain in the hot water till all the soluble gelatine is removed; this is known by the ceasing of the dirty or coloured streams that previously have come from the picture. There is no fear of the print itself being dissolved away, for the altered gelatine that forms it is insoluble. When all that will come away has come away, remove the glass from the warm water, and well wash in cold water; the picture may then be set aside to dry, still adhering to the glass or zinc. When the print is in this state it can easily be seen if the exposure to light under the negative has been too little or too much. If it has been too little, the print will be too light, that is, there will not be enough pigmented gelatine left on the glass to properly represent the negative, showing that sufficient time was not given for the light to render enough of the gelatine insoluble. The print will betray the deficiency of exposure by the absence of the half-tones. If the print is too dark, then the exposure has been too great, and too much of the gelatine has been rendered insoluble. If either error has been committed a mark should be made on the margin of the negative showing the greater or lesser number of tints that the negative should receive in future printings. Gelatine prints never look sharp when they are wet; they will be sharp enough when the gelatine is hard and dry. After the print is dry, proceed to transfer it to the permanent paper base to which it is to remain. Ordinary plain paper, or even paper slightly gelatinized, is not sufficient for finally attaching to the image on the glass or zinc. If such papers be attached to the gelatine image the finer parts of the high lights and half-tones are so attenuated that this kind of paper will be sure to leave them behind. There is, however, a paper provided with a coating of insoluble gelatine that readily attaches itself to the image, and brings it all off the glass

perfectly. Pour boiling water in a flat dish and immerse the transfer paper supplied by the Autotype Company; many sheets may be immersed at a time. One side of the paper is covered with a gelatinous layer that softens but is not soluble in even boiling water. Allow it to remain in the hot water until it thoroughly softens and becomes pulpy. When it has arrived at this condition, lay it on the image on the glass or zinc, and with the squeegee smooth it down so as to be in close contact, and, by stroking the paper, expel superfluous moisture. Allow the paper to dry. When thoroughly dry the paper may be stripped from the glass, bringing the print with it. In some cases it will come off spontaneously, but usually it may be started at the corners and will come off freely. Sometimes it may be dry at the corners and damp in the middle; wait till it is quite dry all over, as it will not be forced. Occasionally it may happen that even when it is quite dry it will not freely come away; a little heat may then be applied to the glass, and the print will almost fly off. In such instances there has been rather too much resin in the waxing solution that was applied to the support; remedy, add a little more wax. If, on the other hand, there be too much wax and not enough resin, the print will come away too easily before it is even quite dry. A little turpentine or benzole should be rubbed over the surface of the print, to remove any of the wax and resin that may show on the face. In every stage of the process many prints may be carried on simultaneously, more particularly in the development. If the prints are considered too dull, increased glaze may be given—thereby increasing the brilliancy—by the use of varnish, collodion, or other glazing materials. This may be done before the pictures are finally mounted on cardboard, or afterwards. There is one point of great importance in carbon printing, the edges of the pigmented paper must never be exposed to light. It is not sufficient that the carbon paper is smaller than the negative, but all around the margin of the negative a safe edge of a band of dark paper, or black varnish, must be put to protect from light for a $\frac{1}{4}$ of an inch the edges of the pigmented paper. If the margin of the print has been protected from light it remains soluble, and it retains its adhesive property, and thus the whole print is securely attached by the edges, and the water cannot get between the film and the support, but can only act on the face of the print. There is a method by which the pigmented tissue is attached at once, after coming from the printing frame, on to paper, instead of to a temporary support; when development is finished the picture is complete without any further transferring. The prints so produced are all reversed; it is therefore necessary in working by this method to either take reversed negatives in the camera, or to strip the negatives off the glass so as to use them from the contrary side. It will be seen that the entire principle of this printing process depends upon obtaining an image in insoluble gelatine, and the colour of the image will chiefly depend on the colouring substance, or pigment, that is held imprisoned in the insoluble image.

Gum and Gallic Acid Process.—Any good collodion may be used, but commercial ones may be improved by the addition of 2 grains to the ounce of bromide of cadmium. The nitrate bath should be as nearly neutral as possible, and not of less strength than 40 grains an ounce. Allow the plate coated with collodion to remain from 10 minutes to a quarter of an hour in the bath, so as to sensitize thoroughly; wash in distilled water in two successive dipping baths, then under the tap, and finish with distilled water; then flood the plate, still wet, with the following solution;—1. Picked gum arabic, 20 grains; sugar-candy, 5 grains; distilled water, 1 oz. 2. Gallic acid, 3 grains; hot water, 1 oz. Dissolve these two solutions separately, and mix in equal proportions, filter at the time of using. The first portion of the solution should be allowed to freely flow off, carrying with it the water on

the film. A second portion should be allowed to soak into the film for about a minute, and then be poured off, and the plate put away to drain and dry in a dark place. The plates must be edged with india-rubber solution, or dilute albumen, or varnish, before development. The exposure in summer time with good light will be about twice that of wet plates, but in winter, or a dull light, the exposure will be proportionately longer. The backs of the plates should be painted with some yellow, green, or red colour, to prevent the light passing through, and causing blurring. This paint must be removed after exposure and before developing. The plates will keep for a considerable time before exposure, but in this, as in all dry processes, develop as soon after exposure as convenient.

Photo-Crayon Portraits.—This is a method of producing a delicate style of portrait, consisting of a transparency on glass, the lights of the portrait being formed by a tinted-paper backing. The picture is made from an ordinary portrait negative, which should be soft, sharp, and clean. Place the negative in a copying camera for transparencies, or in the window of a darkened room, and proceed to make a transparency from the negative. An ordinary carte-de-visite vignette, or a cabinet-sized head, is most suitable. Provide a screen outside the camera, and in advance of the negative, of a somewhat oval shape, and allow the light to pass through this aperture on to the negative so that only the head and shoulders are visible, the rest being vignetted gradually away. Make the image to yield a head of about an inch and a half in size. Any ordinary good bromo-iodized collodion will do if half a grain of chloride of ammonium to the ounce is added. The nitrate bath should be as nearly neutral as can be worked without fogging. The developer should be—Pyrogallic acid, 2 grains; citric acid, ½ grain; glacial acetic acid, 30 minims; water, 1 oz. The exposure should be abundant, so that the image rapidly appears when the developer is applied. Very little development is required, as the image must be a thin one and of a purple-brown colour. If the image is under-exposed, or too much developed, it will be a disagreeable colour, and be deficient in delicate definition, as only a very thin transparency is required. During development the action must be carefully watched, something like developing a glass positive, and directly the details are visible—without washing off—saturated solution of hyposulphite must be flooded over the plate to fix it. When fixed the plate must be well washed and dried, and, if the operation is perfect, the transparency will show, when laid on white paper, as a portrait with a white vignetted margin, the whites in all cases being supplied by the paper backing. Much of the beauty of these pictures is due to the tinted backing not being in absolute contact with the image. These pictures can be produced by the magnesium light.

Diaphanotypes.—Produce a good photograph on plain paper, with all the delicate half-tones of the negative well preserved. Let it be deeply printed, as when it is rendered transparent by the balsam its force is considerably reduced. Do not attach the print to cardboard; retouch the unmounted print in the shadows of the drapery, but do not interfere with the face. Place the print in contact with a piece of the best white plate glass, using the following solution;—Canada balsam, 2 oz.; turpentine, 1 oz. Pour this over the glass in much the same manner as collodion, and lay the print down on it, and with the finger or a soft pad commence from one corner carefully to press out all air-bubbles. When the picture is sufficiently set to paint upon, work in the local colours of the face, drapery, and accessories in oil colours, having a careful regard to the general outlines. It is not necessary to paint in all the shadows as carefully as an artist would do, as the transparent photograph supplies these. When the work is done the effect is very rich and mellow, with the certainty of retaining all the fidelity of the photograph.

The Ivorytype.—Make a good print on plain paper; if the portrait is that of a fair person let the tone of the print be warm, if of a dark person let it be a cold tone. The print has to be coloured on the surface as an ordinary coloured miniature, only colouring it stronger to allow for the toning down it will presently receive. In this stage it will look like an ordinary photograph over-coloured. The next point is to communicate to it the softness, creamy delicacy, and transparency of an ivory miniature. This is effected by attaching it to white plate glass by white wax and gum dammar. Melt in a jar by gentle heat 2 oz. of the best white wax, and add a piece of gum dammar about the size of a hazel nut. When these are thoroughly mixed, place a little on the clean glass plate which is to receive the picture. Heat the plate gently, and when the gum and wax melts and flows over the plate, the coloured photograph must be carefully laid down on the melted wax, the greatest care being taken to avoid air-bubbles and to preserve an equal layer of wax all through. Should air-bubbles show when the plate is cold, or the wax appear unequally thick, the plate can be rewarmed, and with a warm palette knife remove the irregularities by gentle pressure.

Heliotype.—When a layer of varnish composed of gelatine and bichromate of potash is spread upon a suitable surface, and is then dried in the dark, it forms a sensitive compound upon which the light exercises such action as to cause it to resist water, the parts unacted on being capable of absorbing water. An ordinary photographic negative is then placed upon the film, those parts through which the light passes are rendered insoluble, whilst those parts unacted upon by the light, are capable of absorbing moisture, when the negative has been removed, and the film slightly damped. Thus when a roller charged with greasy ink is passed over the surface, the ink adheres to those parts only on which the light acted, the water with which the other parts are charged preventing the adhesion of the ink. The proofs are then obtained by means of the usual printing press—a typographic being preferred to a lithographic press. The details of the process are as follows;—A plate of glass, the surface of which is ground and not polished, having received a coating of wax, and been carefully levelled, a sufficient quantity of a mixture of gelatine, bichromate of potash, and chrome alum is poured over it to form, when spread out and subsequently dried, a film of the thickness of very thin card or thick paper. The coating and drying must be done in a dark room, or one into which only a *yellow* light is admitted. The use of the chrome alum is to prevent the subsequent solubility of the film, this substance having the property of preventing gelatine from becoming again liquid after it has once set; without it the portions of the film that had not been acted on by the light would be at the mercy of the water, which would cause it to become so soft and swollen as to seriously interefere with the successful working of the process, which depends for good results on its firmness and uniformity of condition. The proportion of bichromate of potash to the gelatine is about 5 per cent., but this may be varied to any extent to suit the requirements of the negative, much in the same way as the strength of a silver bath for positive printing is altered for special purposes. After the glass plate has been coated, it is retained in its level position for a few minutes until the film has set sufficiently to permit its being lifted up on its edge, when it is stored away in the drying room, where the temperature is tolerably high, and the atmosphere dry. The drying and store rooms must be dark. In about 24 hours the film has become thoroughly dry, when it is removed from the glass—an operation which is effected with ease, the previous substratum of wax conducing to this end. The advantages derived from the removal of the film from the glass are very great. One of these is, that whereas formerly, when the film remained on the thick plate of glass on which it was printed, it was

difficult to secure perfect contact between the negative and the sensitive surface, and any hollow or inequality in the negative caused a separation to take place between the two plates, loss of sharpness in the printed gelatinous surface being the result. But now that the system of removing the film from the glass has been adopted, its flexibility permits it to be pressed in intimate contact with the negative, no matter whether the latter be flat or not. The next operation is to attach the film to a plate of zinc. This is effected by first placing the plate in a flat vessel of water, and then immersing the gelatine film, bringing both in contact without allowing air-bubbles to intervene. With one or two strokes of a squeegee is secured the intimate union of the sheet of gelatine with the metallic plate, on the sucker principle. After the plate becomes surface-dry—which is the case in a few minutes—a brush charged with india-rubber solution is passed round the margin, which has the effect of preventing the ingress of air when the plate is being printed from. To prevent the film from shifting during subsequent operations, the zinc plate, previous to the laying down of the film, is usually coated with india-rubber varnish. The plate is now ready for furnishing impressions. These are obtained by treating it in much the same way as is a lithographic stone; it is first of all sponged with water; the surplus water is removed by the squeegee, which is followed by pressing over the surface of the plate a sheet of blotting paper. The ink rollers are then passed over it, the ink adhering according to the action of the light. It is in the printing that the great value of the stripping off of the film and transferring it to the zinc plate is seen. In the Albertype process, so long as a plate of glass was used for printing from, an element of extreme danger and uncertainty was present—danger, because any particle of granular matter getting under the plate would ensure its being fractured under the pressure of the printing press. Experience has proved that a greater degree of pressure must be applied to obtain the finest effects of certain subjects than a glass plate can safely bear. The degree of pressure to which a zinc plate may be subjected, compared with that which glass will bear, forms a feature of value in the recent modifications of the heliotype process. When the desired number of prints have been obtained, the film is detached from the zinc plate and placed away in a portifolio, ready for future use. This, also, is an improvement, for, previously, the reserving of some hundreds or thousands of printing films, each of them permanently attached to a large, very thick, and costly piece of plate glass, entailed both expense and inconvenience. As the printing pressure is direct, a considerable number of proofs can be obtained from one film; 1500 uniformly good prints have been thus got. Of course, as the preparation of the printing plate or film involves so little trouble and expense, when a large order has to be executed a number of plates are prepared, and the uniformity of these is ensured by exposing them all to the same actinometric figure. Another point in the process is the adaptation of it to chromotypic printing; by printing upon a sheet of paper previously coloured in broad masses by lithographic or other means. The effect of a heliotype when printed upon such a base is very good. There is no other way by which the peculiar effect of photographs on albumenized paper can be so well obtained as by using paper with an enamelled face. We have stated that the sensitive film of gelatine was formed upon a plate of ground glass. For subjects requiring great delicacy, the upper or shining side of the film is invariably placed next to the negative; but if a granular texture in the finished print be desired—such a texture as would be obtained from a grained lithographic stone—it is only necessary to print upon the granular instead of the smooth side of the film, the degree of granularity depending upon that of the surface of the glass on which the film was prepared. It is found that the stiffness of the ink exercises a marked influence on the image.

A stiff ink adheres only to the deepest shadows, while, on the contrary, a thin ink attaches itself to the demi-tints. Taking advantage of this property, the plates are rolled over with ink or inks to suit the particular kind of work, or the effect wanted. One consequence of this is that, if a very soft picture be required, a thin transparent ink will give the desired quality, while, if the opposite quality be desired, it is only requisite to use a stiff opaque ink. Both can advantageously be combined in one picture. In printing by the heliotype process, the pictures do not require to be mounted like other photographs, for the margin is left clean and white. This renders the process specially applicable for book illustration.

Swan's Process.—Photographs in Pigments.—The tissue is prepared by machinery, by which a perfect and uniform coating is secured. Each piece of paper is made into an endless band revolving round rollers, which keep it stretched, and repeatedly pass it over a surface of melted gelatine, sugar, and pigment, until a perfectly even coating of the right thickness is applied to the whole length. The trough of gelatine is kept at a proper temperature by means of steam. By repeated contact with the gelatine, a thin coating being applied each time it passes over it, a more perfect surface and even thickness of the gelatine is secured than could be obtained by any plan which applied the full thickness at once. By the arrangement adopted, waves of irregular draining are entirely avoided. These lengths of gelatine are then cut up to specific sizes, and will keep ready for sensitizing when required. The paper employed must possess a fine surface, and be free from inequalities and imperfections, so that it may receive an even layer of the gelatine, as any imperfection in this layer may result in a blemish in the picture. It is desirable that the paper shall be sufficiently permeable by the water to facilitate its removal from the gelatine prior to development. The tissue is prepared in three varieties of colour; and in each there are three gradations of intensity to suit negatives of various kinds. The colours are indian ink, sepia, and photographic purple. The indian ink tissue is a pure black, nearly neutral in tone, inclining to warmth. The sepia tissue is of a warm sepia tint. The photographic purple tissue is of a tint resembling that common in gold-toned silver prints, of a purple-brown, in its extreme depths a purple-black. In this pigment printing, although the best picture will result from the best negative, it is possible with a very intense hard negative, possessing abrupt contrasts, to produce extremely soft and harmonious prints; whilst brilliant prints may also be obtained from a feeble negative possessing very little contrast or intensity. It will be seen, then, that by forming the picture in a thin film of insoluble matter of intense colour, vigorous contrasts and perfect gradations from light to dark may be secured with a thin negative; and that by using a thicker film of insoluble matter, less intense in colour, the excessive contrasts of a hard negative may be softened, thus materially ameliorating the faults of bad negatives in either direction. The kind of negative which suits best for Swan's process is a negative of average density, with full detail in the shades, such as is got by ample exposure and development. There should be some, although little, absolutely bare glass; but whatever deposit of silver there is on the deepest shades should be a pure photographic deposit, and not "fog." The tissue is prepared in each tint to suit negatives of three qualities, numbered 1, 2, and 3. No. 1 possesses the smallest proportion of colour, and is suited to the production of harmonious prints from negatives in which, from the nature of the subject, from under-exposure or over-intensifying, the contrasts are abrupt. No. 2 is suited to good negatives of normal character, in which the densest parts are not absolutely opaque. No. 3 possesses a large proportion of colour, and is suited to thin, soft negatives, a little lacking in force and intensity. By a classification of the negatives, and

the use of a suitable quality of tissue for each, it will be found possible to secure more complete control over the character of the prints, and a more perfect uniformity of result than is possible in ordinary silver printing. The tissue should be kept in a cool, dry place, packed flat, and kept under a weight. If exposed to the atmosphere, it will in hot weather curl up and become unmanageably horny; whilst in damp weather it would absorb moisture.

Sensitizing the Tissue, and other subsequent operations, will be conducted in the dark room. A nearly saturated solution of bichromate of potash is employed. As the strength of a saturated solution varies with temperature, make a solution of definite strength, by dissolving such a quantity of bichromate of potash as will not during cold weather crystallize. Such a solution is formed by dissolving 1 lb. of bichromate of potash in 12 lbs. of water. The tissue is immersed by drawing it face upwards, under the solution, contained in a dish 2 or 3 inches deep, care being taken to avoid the formation of air-bubbles. After immersion, the sheet is turned, and with a flat camel-hair pencil remove the bubbles that form on the back; it is then again turned, and drawn repeatedly through the solution. Then attach American clips along one of the edges, and slowly withdraw, so that the solution drains off without being repelled from the face of the tissue, and running off in streams. If the sheet is large, a thin lath of wood may be laid along the edge of the tissue that is first withdrawn from the trough, the tissue and lath being clipped together with American clips. The time of immersion may vary from 1 to 3 minutes, according to the temperature and the facility with which the tissue absorbs the solution. As a rule, as soon as it is quite limp it should be removed. The longer the immersion, within certain limits, the more sensitive will be the tissue; but if too much prolonged, there is a danger of the paper becoming rotten, the gelatine also loses toughness, and the large quantity of water absorbed renders it liable to tear with its own weight. Long immersion in a saturated solution is also apt to produce a crystallized surface in drying, which renders the tissue quite useless. The tissue should be placed to dry in a dark room, through which a current of dry air is constantly passing. In the first stage of drying, the temperature of the air must not be above 70° Fahr., otherwise the gelatine would melt. During damp weather, the air of the drying room may be raised 10° after the tissue has become half dry. If the drying is slow, the development of the image afterwards will be extremely slow or altogether impossible. After complete drying, the sensitive tissue may be kept for several days. By keeping it too long, a discolouration of the print results, and the print develops tardily, and the lights are not clear. As a rule, by sensitizing in the evening, a supply of paper may be prepared for printing next day; 12 hours' suspension in a dry atmosphere being sufficient for the necessary drying. Should the tissue by accident be rendered too dry and horny, it is desirable to hang it for a few minutes in a damp place, when it will quickly become just sufficiently pliant to permit easy manipulation.

Exposure under the Negative.—As the prepared side of the tissue is placed in contact with the negative, if it retained the slightest adhesiveness of surface, it would be dangerous to bring them together. Care must be taken not to use damp tissue. Before placing the tissue in contact with the negative, apply to its surface, with a flat camel-hair brush, some powdered French chalk. This material prevents the risk of the gelatine film adhering to the negative, and serves other useful purposes. On applying it to the gelatine surface, it indicates if any spot is not perfectly dry by adhering there in a patch instead of spreading in a scarcely perceptible coating; it also prevents an excessive absorption of light at those points of the tissue which are in such perfect contact with the negative as to destroy the reflection from its second surface. Although the gloss of the tissue

is slightly deadened by the trace of powder attached, it does not in any degree interfere with the progress of printing, or cause any imperfection in the print. The negative is also rubbed over in the same way; and all risk of the tissue sticking to the negative is removed. For the exposure it is not necessary to use pressure frames with hinged backs, as the print is not examined in progress, the sole guide as to time being the actinometer. The back pressure should be comparatively light, and the backing should be smooth and level. Fine cloth forms an excellent backing. Where the padding of the back is coarse, a piece of smooth cardboard may be placed at the back of the tissue. If the tissue is quite dry, there can be no objection to sun printing; but if the slightest moisture is left in the gelatinous film, prolonged exposure to a hot sun with a dense negative would soften the film, and cause it to adhere. As this tissue is much more sensitive than albumenized paper, printing in diffused light will generally be more convenient, as well as safer. As a rule, the exposure is from one-third to one-half of that required for albumenized paper. In direct sunlight, it may vary from 1 to 10 minutes; in diffused light from 10 minutes to an hour, or even more. In using the actinometer, it must be exposed to the same light as the prints, the progress of which it is to indicate.

Mounting and Preparing for Development of the Image.—As the washing away of the superfluous compound must be effected at the side opposite to that which was in contact with the negative, before commencing development, the tissue must be mounted on another piece of paper with a material which is not affected by water, in order that the paper upon which the compound has rested up to the present time may be removed, so as to expose the hitherto protected surface to the water. As the paper upon which the tissue has to be supported, during future operations, is placed in contact with the surface which will be the surface of the finished print, it should be smooth and free from blemish; and it should be sufficiently tough to bear the treatment necessary in hot water. Fine Saxe paper answers well. A solution of india-rubber is used for mounting the tissue. Pure india-rubber should be cut up into fine shreds, and dissolved in pure benzole at the rate of about 10 grains to 1 oz. of the solvent. When properly prepared, it forms a thin varnish, but it leaves a palpable film of india-rubber on the paper to which it is applied. When desirable to hasten the complete solution, covering the shreds of india-rubber with a little chloroform will quickly reduce them to a pasty mass, readily dissolved by the addition of benzole. The india-rubber solution is poured into a flat dish, and the paper drawn over it, so as to secure an even coating on the whole surface. The paper is then hung up by American clips to dry. The tissue, removed from the negative, having been wiped to remove the French chalk, is floated over the surface of the india-rubber solution in the same manner, care being taken not to allow it to sink below the surface; it is then hung up to dry for about an hour. When the india-rubber on both the paper and the tissue is dry, the extreme edge of the tissue is cut off, and the two coated surfaces are carefully brought into contact, and in order to secure perfect contact and cohesion, they must be submitted to heavy rolling pressure. The coated surfaces should be preserved from dust and from contact with anything which could impair the cohesion of the india-rubber surfaces. In bringing the tissue into contact with the india-rubber coated paper, the tissue should be bent back, so that contact is first made with the middle of the print; the ends of the tissue being then allowed to fall after first contact. After being placed, the back of the tissue may be lightly rubbed with the hand or a pad, the rubbing being from the centre outwards. Several prints may be attached to one piece of paper. In rolling, the india-rubber coated paper is laid on the steel plate, and a blanket of thick felt is laid over the tissue, which is uppermost, whilst it passes through the press. Although the prepared surface of the sensitive tissue must be always carefully

shielded from light, when once that has been covered up by mounting, it may be submitted to a dull, diffused light with impunity, care being taken that the back of the original tissue is uppermost. This permits the rolling of the mounted tissue to be effected in a moderately light room. The back of each print should be examined, and any india-rubber solution removed by rubbing with a piece of india-rubber. The print is now ready for development. To effect this a plentiful supply of warm water is necessary. Three large wooden troughs should be used, provided with hot and cold water taps and waste-pipe. Into these troughs pass the prints in succession. But the same result could be obtained on a more limited scale in photographic dishes, and by having at hand a large vessel of hot water, as well as the ordinary cold water supply. The prints must be first immersed in cold water, all air-bubbles being carefully removed. Here they are left for half an hour or more, as may be convenient, to permit the water to penetrate and soften the gelatine; after this, place them one by one in water of from 80° to 100° Fahr. This immediately loosens the backing paper upon which the tissue compound was originally coated, which must be stripped off. It is separated from the tissue at one edge, and lifted gently away. If it should still adhere, a little longer soaking in the warm water will be necessary to effect the removal of the paper; but this is always a bad sign. The back surface of the tissue, opposite to that which was exposed, is now uncovered; and the next operation is to remove all gelatine, pigment, and chromic salt which have not been rendered insoluble. As the sensitive surface is now exposed, strong white light should be avoided until the bichromate has been washed out of the film. A large portion has been removed whilst the print was soaking; and now that the gelatinous compound is exposed, the salt is rapidly diffused in the water. The process of clearing may be accelerated by allowing a gentle stream of warm water to fall on the surface of the print, but if the print is left face down in the warm water, in from five minutes to a quarter of an hour it will have parted with nearly all the superfluous gelatine and colour, presenting the image in its proper gradations, and only requiring a little further washing to complete the operation. If, from over-exposure, the picture appears too dark, or the image appears slowly, the temperature may be raised, when necessary, to 150° Fahr.; but high temperature must not be used until all the development has been effected that can be effected by water of a lower temperature. The development is best commenced at as low a temparature as possible; and, as soon as the image is fully made out, the print should be removed to cold water, in which the residue of bichromate will be washed away without injury to the delicate half-tones, which would, with an under-exposed print, disappear in hot water. After 2 or 3 hours' immersion in cold water, the prints are one by one re-immersed in water at 80° or 90°. Those which show signs of under-exposure are very carefully rinsed in merely tepid water, say 80°, to clear away the soluble gelatine and adherent colour; after which they are suspended to dry. The more fully-exposed prints remain in the warm water until they become light enough. Any that are over-exposed are put into hot water, and are allowed to remain until the depth is sufficiently reduced. By using merely tepid water at the commencement of the operation, any under-exposed prints are discovered and saved. Then, by the use of hot water to the more fully-exposed prints, these are speedily lightened to the required degree, and very few prints are lost from under or over exposure. When sufficient gelatine and colouring matter have been removed, and the prints are fully developed, they are hung up to dry. It is most important to preserve uniformity of action. It is desirable to keep the face downwards until the development is completed, and to remove air-bubbles whenever they form. It should be remembered, in observing the depth of the picture, that it is seen on a ground covered by the coating of india-rubber, which gives the paper a brown tint,

and that when transferred to pure white paper, it will possess much greater brilliancy. The picture up to the present time presents an image in which right and left are reversed. It is now necessary to transfer it from the paper which has supported it temporarily for manipulation, to its final resting place, in which operation right and left will resume their proper relations. The image may be transferred to a sheet of cardboard, so as to require no further mounting, or to paper; in the latter case, it is simply in the position of an ordinary print, and will require subsequent mounting.

Transferring to Cardboard.—The face of the dried print is very evenly coated, by floating, or by means of a flat camel-hair brush, with the following preparation;—Gelatine, 2 oz.; glycerine, $\frac{1}{2}$ oz.; water, 1 pint. The gelatine should be melted and carefully cleared of air by long heating, and skimming the froth; after which the glycerine is added. It will always require melting by heat, and straining through wet flannel or muslin before use; it is then applied evenly to the surface, by floating, and hung up to dry. When dry the print is trimmed to the required shape. A piece of stout cardboard of the required size, pure in colour and fine in surface, is passed through clean water, and drained. Upon the moistened surface the print is laid, face downwards, exactly in the position it is to occupy, and the card is taken to the rolling press and placed on the polished steel plate, print side downwards, the side on which the print is placed being in contact with the plate, and a felt blanket on the back of the card; it is submitted to a heavy rolling pressure, and put aside to dry. The cardboard must be perfectly moistened all over, as, if any point is omitted, the adhesion of the print in that place would not be secured. As each part is submitted to the rolling pressure, a wave, infinitely small however, is driven before the pressure, effectually displacing air, and securing perfect contact. There should be no delay in applying the pressure after the print has been placed in contact with the moistened surface, as the image, by absorbing moisture, might, under the heavy pressure, lose something in sharpness. As each print is passed through the rolling press, it is placed upon the last, and when the pile is completed, a weight is placed upon the whole heap, the prints then dry without warping; and at the expiration of about 24 hours they are ready for the final operation. This is, removing the paper which has supported the image during the operations of developing and washing. The picture must be quite dry before the operation is attempted. A piece of clean cotton wool is saturated with pure benzole, and the india-rubber coated paper which covers the print is rubbed pretty hard with it. An edge of the paper is then gently raised with the point of a blunt knife, care being taken to commence at a black part of the picture where the film of the image is thickest. The raised edge is then taken hold of, and pulled so as to tear it gently and steadily off the print. Instead of removing the paper with an upward or lifting motion, it is better to turn it backwards, as there is less danger to the surface of the print at any point in which the adhesion in mounting is imperfect. As a general rule, especially when the benzole is used sparingly, the paper brings away with it all the india-rubber coating; but any traces remaining may be rubbed away with india-rubber. Under ordinary circumstances, the picture is now finished. If required for colouring, the print may be coated with plain collodion, or a suitable sizing preparation. The manipulations in transferring to paper are very similar to those just described, but are a little more easy. It is not necessary to trim the print to its proper size or shape, as this will be done in the final mounting. The mounting papers are carefully immersed in water, air-bubbles being brushed away, and then laid one upon another while in the water; they are then drawn out in a pack, and suspended to drain for some hours, or pressed to remove the superfluous water; a perfectly even film of moisture is thus secured. Place the print, face upwards, on the steel plate of the press,

and over the print is laid the moistened paper, and on that a felt blanket. The press is then pulled. The print is next immersed for an hour in a bath, containing 5 per cent. of alum, and is afterwards well washed in water and dried, after which it is uncovered as when mounted on cardboard. By transferring to paper it will be observed that facility is afforded for performing the last-mentioned operation, by which an additional source of stability is secured. A solution of common alum has, to a certain extent, the power of waterproofing the prints, and generally fixture with alum is quite sufficient. Where, however, more thorough waterproofing is required, the prints, after transfer, should be treated with a 1 per cent. solution of chrome alum. Prints intended for colouring in water colour should be chrome-fixed.

Sensitive Collodio-Gelatine Tissue.—To prepare the sensitive collodio-gelatine tissue, take a sheet of plate glass, free from blemishes or scratches, and clean it perfectly, finally rubbing the surface with a saturated solution of beeswax in ether. This is wiped off with a clean cloth, leaving a scarcely perceptible coating of the wax. This coating tends to facilitate the future removal of the tissue from the glass. Now coat the glass with plain collodion, giving a thick, tough, transparent film. The pyroxyline should be of the kind which yields a film free from opacity. About ten grains in an ounce of solvent, consisting of equal parts of ether and alcohol, will answer the purpose. This film must be dry before applying the tissue compound. Make a solution of pure gelatine 2 oz., white sugar ½ oz., water 8 oz. The kind of pigment to be employed, and the proportion in which it is to be added, will depend on circumstances, but it is especially important in the preparation of this tissue, that the pigment employed should be so finely divided that no subsidence will take place during the period the tissue compound remains in the fluid state upon the glass. The preparation in this state may be kept ready for use. It should be kept in a well-corked, wide-mouthed bottle; in hot weather it is apt to decompose if kept long. It may be poured into a flat dish to the depth of about half an inch, and when nearly dry cut into shreds, and thoroughly dried; in which state it may be kept without risk of injury. When required for use it must be soaked again in eight parts of water. The proportion of gelatine and of sugar will be influenced by the quality of the gelatine, the temperature, and other conditions, in which experience must be the guide. In very dry weather the proportion of sugar may be increased. To prepare the tissue compound for use, heat must be applied until it is quite fluid, when one part of a saturated solution of bichromate of ammonia must be added to every ten parts of the gelatinous compound, after which the whole should be strained through flannel. It is desirable, after the chromic salt has been added to the gelatine, to avoid applying a greater heat than is necessary to preserve fluidity, as excess of heat tends to produce insolubility. About 100° Fahr. will generally answer the purpose. It must be remembered that frequent application of heat to gelatine destroys its setting powers, and renders the preparation useless. If the tissue is too thin the finished picture will not possess its proper depth of shade in its darkest parts, unless it has had an unusually large proportion of colouring matter. If too thick, drying is retarded, and it is intractable in manipulation; it will also require a longer time in development. As a general rule, about 2 oz. will be required for each superficial foot. Immediately previous to the preparation of a sheet of tissue, the piece of patent plate glass should be placed in a perfectly horizontal position, a spirit-level being used in the adjustment. The tissue compound, warmed to 100°, should be strained through a piece of moist flannel or muslin, and when ready the plate should be warmed until it is of the same temperature as the compound. The proper amount is then poured on the collodionized plate, and caused to flow over its surface, a glass

rod being used to spread the solution. The coated plate is then left on the stand until it is quite set. When once thoroughly set, the plates may be placed away in an upright position to dry. The more quickly the drying is effected, provided heat is not applied, the better. The temperature should not exceed 60° or 70° Fahr., as a higher temperature may cause the gelatine to run and form uneven waves. In a dry, well-ventilated dark room, kept at a temperature of about 60° Fahr., drying will generally take place within twelve hours, and without any danger to the solubility of the tissue. It is desirable in damp weather to use a drying box, containing chloride of calcium, or other substance having great affinity for water. When the tissue is dry it is ready for printing, it is removed from the glass and placed in the pressure frame, with the collodion surface in contact with the negative. The proper exposure is ascertained by the actinometer. Before development, the tissue is coated with india-rubber solution in the same manner as the paper tissue, and is mounted on paper coated with india-rubber. It is then developed, washed, dried, and transferred as already described; the film of collodion in this instance forming the surface of the finished print. Instead of coating the glass plate with collodion, it may be rubbed with ox-gall, or with the solution of wax before mentioned, and coated with the sensitive tissue compound. When this is dry it may be coated with collodion, removed from the glass, and treated in the manner already described. Or it may, instead of being coated with collodion, have a sheet of wet paper applied to it, and pressed in contact so as to adhere. It is then suffered to dry, and treated as the paper tissue in all respects, its only difference consisting in the fine surface communicated by the plate glass, which becomes finally the surface of the transferred picture, and possesses more delicacy of effect than that produced by the ordinary paper tissue.

The Pigment employed.—Where effects resembling artists' drawings are required, which, in reproductions will often be valuable, it is quite possible to produce them. The effect of a drawing in lead pencil may be imitated by using graphite as the pigment; red chalk may be imitated by Venetian red; for sepia and bistre effects these pigments themselves may be used. For most purposes, however, a fine black, either neutral, or inclining to brown or purple, will be preferred. Fine lamp-black, or good indian ink, in such case will generally form the basis of the colouring matter. If the colour required is a pure neutral black, the addition of a blue pigment is necessary, to neutralize the brown tint of indian ink; and, where necessary, coldness is corrected by the addition of some warm colour. The selection of this colour will be governed by the tint desired, and by the permanency. Many of the most beautiful tints are most fugitive. Carmine, for instance, is unstable. Crimson lake is a valuable colour, but it is not strictly permanent. Indian red is a very powerful and very permanent colour. Venetian red is also permanent. Ultra-marine blue is satisfactory as regards permanence. In judging colours it must be remembered that the actual effect of colour employed is chiefly seen in middle tint. It is difficult to distinguish much difference between a blue-black, a brown-black, or a purple-black, in the extreme darks of a picture; but the tone is easily distinguished in middle tint, and, as a rule, warm half-tones are the most pleasing. By the addition of a large proportion of colour to the gelatine, a vigorous print may be obtained from a feeble negative, and by the use of a small proportion of colour a hard and intense negative may be made to yield soft prints. As a normal proportion for good negatives 2 per cent. of carbon is sufficient. The proportion of pigment required varies with different pigments, and depends upon the power of the colour employed.

Colouring Carbon Prints.—Carbon photographs admit of colouring in oil, water, or powder colours, without risk of damage; the manipulation is easier than that upon albumenized silver prints,

Powder colours adhere very readily to the surface of these prints. By breathing on the picture a still more adherent surface is obtained.

Water Colours.—The water colours take kindly without any preparation, washing well, and permitting tint to be worked over tint without difficulty, and the surface may be made more pleasant for working on by the application of a coating of sizing preparation. The plain carbon print so treated acquires an even, clear surface, losing all gloss without any loss of depth or transparency.

Oil Colours.—The best mode of preparing a carbon print for the reception of oil colours is by sizing it with isinglass. A solution of about 2 per cent. of isinglass in equal parts of hot water and spirits of wine, carefully applied, not too hot, to the surface of the carbon print, with a flat camel-hair brush, yields a surface upon which oil colours work admirably.

Re-touching Carbon Prints.—In the ordinary process of re-touching carbon prints, to remove small imperfections, it is only necessary to use the proper colour in the usual way; if a little gelatine, with a trace of a chromic salt, is employed with the colour, it will, when dry, become insoluble like the rest of the picture. If the re-touching is effected with the same materials before transferring the print, it will, when the picture is finished, be under the image, and no inequality of surface, usually apparent after touching, will be seen.

Failures, Faults, and Remedies.—Spontaneous Insolubility of the Tissue.—This arises chiefly from slow drying, or long keeping in a damp place. The addition of substances to give elasticity, such as glycerine, which retard the drying of the gelatine film, also tend to produce spontaneous insolubility. Heat in conjunction with the moisture increases the tendency. The use of too much bichromate of potash, or too prolonged immersion in the solution of bichromate, will produce spontaneous insolubility. Immersion in very hot water, prior to development, is at times conducive to insolubility, also drying the tissue in an impure atmosphere, and especially one vitiated by the burning of gas.

Tardy Solution of the Superfluous Gelatine Development.—The same causes which produce spontaneous insolubility when present in less degree, cause tardy solution of the unaltered gelatine, and slow development. The more rapidly the tissue has dried, and the more horny it appears, the more readily, as a general rule, the superfluous gelatine and pigment are removed by warm water, and complete development is effected. When the development is slow, hotter water may be employed; but care should be taken that the free soluble bichromate has first been removed by tepid water.

Bichromate of Potash Crystallizing on the Tissue in Drying.—If the tissue is allowed to remain too long in a saturated solution of bichromate of potash, the salt will crystallize on the surface during drying, and the tissue will be useless. The remedy of course is the employment of a weaker solution, or a shorter immersion in the full-strength solution.

Uneven Development.—If the print is allowed to float to the surface of the warm water, allowing portions to become dry; or if some portions of the paper forming the original basis of the gelatine are allowed to become detached long in advance of the remainder, so that the warm water acts directly on the soluble matter in patches, the result will be uneven development, the portions last uncovered remaining darker than the rest of the print; and it will be difficult to equalize the tint, even by long-continued development.

Blisters during Development.—If, in mounting the tissue with the india-rubber solution, perfect contact in all parts is not secured, blisters will arise in the course of development, which will show as marks or defects in the finished print. Passing the combined sheets of tissue and india-rubber coated paper through a powerful rolling press prevents this.

Over-Exposure.—An over-exposed print will develop tardily, and continue, under ordinary treatment, too dark. After all the soluble chromic salts are removed, the temperature of the water

may be raised, and by long soaking in hot water the depth may be reduced considerably. Immersion for a short time in a very weak solution of chloride of lime, or of hypochlorite of soda, or in chlorine water, or peroxide of hydrogen, rapidly reduces a print, by decomposing a portion of the insoluble chromo-gelatine compound, and restoring it to its original condition of solubility. Protracted immersion in hot water is the best remedy.

Under-Exposure.—An under-exposed print develops rapidly, the lighter half-tones quickly disappearing. When this is seen, quickly remove the print to cold water, and by skilful manipulation and attention, and the after-use of almost cold water, say under 80°, a brilliant print may be secured.

Weak and Flat Prints.—When a feeble print is obtained from a good negative, it may arise from the use of a tissue containing too small a proportion of colour, or from the tissue being old and partially decomposed by slow drying. If the negative is weak, the use of a tissue containing a large proportion of colour will yield a vigorous image. Increased vigour may be obtained from an ordinary sample of tissue, by sensitizing it on the paper side of the tissue only, instead of immersing the whole. Printing in direct sunshine aids in obtaining a vigorous print.

Hardness and Excessive Contrast.—This may arise from an unsuitable negative, or from the injudicious use of too hot water on a lightly exposed print, or from the use of tissue containing an excessive proportion of colour, especially in conjunction with under-exposure. Sensitizing the tissue on the prepared side will tend to produce softness, even with a dense negative.

An Uneven Texture in the Finished Print arises from unequal and insufficient pressure in transferring. This unequal pressure may arise from the coating of india-rubber being uneven, or, more probably, from the coating of clear gelatine being applied in uneven streaks, or from uneven texture of blanket, or uneven pressure.

Portions of the Image tearing off in Transferring arises from the face of the print being imperfectly coated with gelatine, or from the paper or board to which the print is transferred having an imperfectly moistened surface, or from not being dry when the paper is removed, or soiled by fingering or dust.

A Green Tint pervading the Blacks is caused by imperfect washing of the print, by which traces of soluble chromic salt are left in the image.

Unequal Sensitiveness.—This arises from the tissue having imbibed the bichromate solution unequally. If, in immersing the tissue, one portion remains dry while the rest is wet, that portion will be least sensitive, and will form a light patch in the picture. If the tissue is raised out of the bichromate in such a manner that streams of the solution run down the sheet, there will be in the print patches or streaks of a darker colour.

The Gelatinous Coating will Run in Sensitizing, if the bichromate solution is too warm, and the tissue kept too long immersed. During summer it is necessary to keep the bichromate solution as cool as possible, and to sensitize in the coolest place that can be procured.

Dark Spots.—If a piece of tissue is printed under too heavy a pressure, dark spots or patches appear in the half-tones. This is most apt to occur if the tissue is limp, and the pressure of the back of the printing frame not only strong, but uneven from coarse padding.

A Sparkling Appearance in the Print after final Transfer.—This arises from the transfer process being imperfectly performed, the paper being either too wet, or too slight pressure used, or the blanket not sufficiently yielding to diffuse the pressure equally over all the surface of the print.

Dry Collodion Process.—The wet collodion process is found very inconvenient for photographs of scenery, and buildings, when the operator is away from his base of operations. He must either carry a tent, to use as a dark room, an awkward addition to his lug-

gage, or he must treat his collodionized plates so as to preserve their sensibility for a longer or shorter period. There are many well-known processes in use, by which the plates are prepared and sensitized before starting on a journey, exposed at the desired situation, and developed on return home. In all the processes the plates are coated with iodized collodion, washed, and sensitized in the nitrate of silver bath, in the same manner as in the wet collodion process, but the means taken to preserve the sensitiveness of the plates vary greatly. If an ordinary negative plate, when removed from the nitrate of silver bath, be allowed to dry, it loses nearly all sensibility, and cannot be developed, as the nitrate of silver crystallizes on the glass. The dried collodion film, when wetted, does not return to its former soft porous condition, but is apt to peel off. It has been found that dilute spirits of wine poured over the dried plate prior to developing, will to a certain extent restore the collodion to its proper condition. When the alcohol has well soaked in, wash the plate, and develop as with wet collodion plates. This simply washed and dried plate is the easiest form of dry collodion process, but is unreliable. By the addition of half per cent. of resin to the collodion, or a few drops of amber varnish, the chances of failure are lessened, as the film is more likely to adhere to the glass. Treat the plates as with ordinary collodion; when taken out of the nitrate of silver bath, wash and place to dry in the dark. Varnish the edges of the film, and when about to use the plate dip it in a nitrate of silver bath. These plates must be used the day after preparation. The time of exposure in the camera must be about three times as long as for the wet process; develop with a solution of gallic acid. Another simple operation is to coat an ordinary wet plate with a solution of dextrine. Dissolve one part by weight of dextrine in ten parts water, allow to settle, pour off the clear portion. Remove plate from nitrate of silver bath, wash, pour some of the dextrine evenly over the plate, drain and dry in the dark. Thus prepared, plates may be preserved several days; exposure three times as long as for wet collodion. Before developing, wash in clean water, develop with pyrogallic acid.

Preservative Solution for Sensitive Plates.—Honey, 3 oz.; distilled water, 5 oz. This mixture is to be poured over the sensitive plate after it has been removed from the silver bath and well drained upon blotting paper. The solution should be filtered before use and poured over the plate several times; it should be then drained for a few minutes and kept in the slide or dark box; it will keep sensitive for several days. The following dry processes, though less simple, are far more efficient and trustworthy than the washed plates. For open-air views, a careful consideration of the size of diaphragm to be used is necessary; the smaller the opening the more brilliant will be the picture, but a longer exposure will be necessary than with a diaphragm having a large opening.

Collodio-Albumen Process.—Coat the plate with ordinary bromo-iodized collodion, pour it on as usual, let it set well before placing the plate in the nitrate of silver bath, and use a pneumatic holder, so that the collodion may completely coat the plate. Place the plate in the nitrate of silver bath, remove and wash with several waters, place it in a pan half filled with a solution of 3 grains of iodide of potassium to an ounce of water, in which let it remain whilst preparing the next plate. Then remove, wash well, and pour over the collodion surface some of the iodized albumen solution, letting it float backwards and forwards on the plate so as to saturate the film; pour off the solution, and repeat the operation with a fresh quantity of the iodized albumen; pour off, and set the plate to drain on blotting paper. The final drying may be done by artificial heat. Plates thus prepared must be kept dry; they are almost insensitive to light, and will remain good for a long time. To

sensitize, heat the plate over a spirit lamp or before a fire; when cool, immerse it in the aceto-nitrate bath for one minute, using only a yellow light, then wash thoroughly, and stand to dry in the dark. The plates should not be sensitized the second time too long before they are to be used, although they will keep for a few weeks in warm weather, and even longer in cold weather. Exposure about six times as long as ordinary wet collodion. A little over-exposure is better than under-exposure, as the great point is to bring out all the details, even in the darkest shadows. Develop with plain pyrogallic acid, and intensify with acid silver solution. After developing, fix with the hyposulphite of soda solution as used for wet collodion plates.

Nitrate of Silver Bath.—1 oz. recrystallized nitrate of silver, 12 oz. distilled water, ½ oz. glacial acetic acid, and 2 grains iodide of potassium. Dissolve and filter.

Iodized Albumen. — 2½ oz. distilled water, 10 oz. albumen, 50 grains iodide of potassium, 10 grains bromide of ammonium, 120 minims strong liquor ammoniæ. Beat to a froth, allow to settle. Filter before use. This mixture will keep good a considerable time.

Aceto-Nitrate Bath. — 30 grains nitrate of silver, ½ dram glacial acetic acid, 1 oz. distilled water. After using this bath for sensitizing the plates, it will be discoloured; pour it into a bottle containing about 2 oz. of kaolin, shake, and stand to settle; the kaolin in subsiding will carry down the colouring matter.

Plain Pyrogallic Developer. — Two grains pyrogallic acid to every ounce of water. Let the film on the dry plate be well wetted with clean water, then pour on the solution; as soon as all the details of the picture have come out, add a few drops of the following solution to that on the plate;—

Intensifying Solution.—15 grains nitrate of silver, 10 grains citric acid, 1 oz. water.

Alkaline Pyrogallic Developer.—Make the following mixtures, and keep in 3 separate bottles;—1. 96 grains pyrogallic acid, and 1 oz. alcohol. 2. 96 grains carbonate of ammonia in 1 oz. water. 3. 10 grains bromide of potassium in 1 oz. water. When about to use, mix 10 minims of No. 1, 5 minims No. 3, with 1 oz. water; pour over the wetted plate, let it remain on a few seconds, pour the solution back into the cup, and add to it 5 minims of No. 2, pour on to the plate again. More of No. 2 may be added, if the details do not come out well; but if too much is used, fogging may occur before the development is completed. The solution of bromide of potassium is to check fogging; but as it also checks development, the less of it that is used the better. Pour off the developer, wash and intensify with pyrogallic acid and the acid silver solution.

Collodio-Albumen Process, adapted for preparing a large number of plates, and especially for obtaining stereoscopic positives. Glasses having all been cleaned beforehand, by the following method a hundred plates, not exceeding 9 in. by 7 in., may be prepared in a few hours. A gutta-percha or porcelain dish must be placed in the dark room, containing a bath composed of 1050 grains fused nitrate of silver in 35 oz. water. Use a mixture of ⅔ ordinary negative collodion, and ⅓ of ether and alcohol, in the proportion of 2 parts ether to 1 of alcohol. Have a large tub of distilled water in the dark room—near the nitrate of silver bath. Coat a plate with the collodion, and place it in the nitrate of silver bath; as soon as it is sensitized remove it to the water trough, then coat another plate, and follow the same process, taking care that the plates have sufficient water to remove the nitrate of silver. The plates should remain in the water about 10 minutes, and should be placed upright, and not touching each other. If the tub is small, change the water frequently, throwing it into a waste-liquor vessel. When all the plates have been well washed, pour a solution of common salt into the waste; this will cause a precipitate of chloride of silver, which can be

reduced to metallic silver by fusion with some carbonate of soda, in a crucible. By having two nitrate of silver baths, and two washing troughs, much greater rapidity can be obtained, as whilst the plate in one bath is being sensitized, another can be collodionized and placed in the other bath; then remove the sensitized plate to the water trough, and proceed with another plate. When sufficiently washed, drain the plates, and stand them on blotting paper, collodion side to the wall. Before they are quite dry, pour a small quantity of albumen over the collodion, to remove the remaining water, drain this albumen into a separate bottle; then pour a fresh quantity of albumen on the plate, letting it flow over every part of the collodion film, return the surplus albumen to the bottle, stand the plate to dry, coated side to the wall to avoid dust, and resting on blotting paper as before. Avoid letting the albumen run round to the back of the plate; if a little should accidentally do so, let it dry, and then remove with damp bibulous paper. Keep the dark room as free as possible from floating dust whilst the plates are drying, which will take about 12 hours. When dry, pack the plates in a grooved box; and, if protected from damp or direct light, they can be preserved a considerable time.

Albumen.—To the white of each egg add $7\frac{1}{2}$ grains iodide of potassium dissolved in $7\frac{1}{2}$ grains water. Beat to a froth, stand to settle, pour the clear portion into a wide-mouthed bottle, and keep in a cool place.

Sensitizing the Plates for Use.—This operation must only be performed the day before the plates are required, and in the dark room.

Nitrate of Silver Solution.—16 oz. distilled water, 1 oz. glacial acetic acid, $1\frac{1}{2}$ oz. fused nitrate of silver. Filter. When discoloured by use, shake up with kaolin and allow to settle. Place the plate in a bath of the above for about 15 seconds, wash well, stand to dry. When dry it is ready for exposure in the camera; time twice or thrice that required for ordinary collodion plates. After exposure, a few days may elapse before developing, but the shorter the period the better will be the result.

Developing.—To 15 grains gallic acid in a porcelain capsule, add 3 oz. hot water, mix well. When the gallic acid is dissolved, add 13 oz. cold water, filter for use. Then make a solution composed of 230 grains fused nitrate of silver, and 9 minims glacial acetic acid dissolved in 35 oz. water. Add $\frac{1}{4}$ of a dram of the latter solution to every 3 oz. of the former; the whole must be thoroughly incorporated; pour into a porcelain dish, a little larger than the plates, about an inch of depth of the mixture. Immerse the plate in the bath, and agitate it a little at first. The time necessary for development varies with the temperature, which should be about 70° Fahr.; a little more nitrate of silver solution will hasten it, but if too much is added fogging will take place. With proper solutions about 4 hours is usually sufficient. If the gallic acid bath turns muddy, remove and wash the plate, and place in a fresh solution of gallic acid, containing less of the nitrate of silver mixture than was previously added. When well developed, wash the plate, and fix with hyposulphite of soda, as described in the wet process, then wash and dry.

Causes of Failures.—Under-exposure of a plate is fatal. If, after long standing in the developing solution, only the sky is well marked, the plate is useless. An over-exposed plate develops rapidly, and if removed from the bath before the whole picture turns grey, a passable result may be obtained. If the sky begins to show about an hour after the plate is placed to develop, and gradually turns to an intense black, and the dark shadows remain perfectly transparent, the plate is successful.

To Prevent Film Splitting.—In all dry processes the film when wetted has a tendency to loosen from the glass and split; this may be avoided either by painting for about $\frac{1}{4}$ inch round the edge of the plate with a solution of india-rubber 2 grains, benzole 1 oz., or by applying to the whole of the plate a substratum of albu-

men 1 oz., water 20 oz., liquid ammonia ½ dram, to be well shaken together and allowed to stand until clear. These also prevent water getting under the film during preparation. It is essential that the collodion should be allowed to set well before immersion in the silver bath.

THE HONEY PROCESS.—Clean, coat, and sensitize the plate in the usual manner; then place it in a bath of distilled water, washing more or less as it may be required to be kept for a longer or shorter time. Pour on the plate a solution made of equal parts of honey and distilled water, and applied in the same manner as the collodion; throw away the first portion, and repeat the operation, letting the solution soak in for one or two minutes; pour back the honey solution to its bottle, drain the plate on blotting paper, keep it in the dark and free from dust. Exposure about double for the ordinary wet process. Previous to developing, soak the plate in distilled water, to soften or remove the film of honey; the older the plate, the more soaking will be required; then dip the plate into the silver bath and develop in the usual way.

THE TANNIN PROCESS.—Clean the glasses with a mixture of tripoli powder, spirits of wine, and solution of ammonia, applied by a tuft of cotton. Wash in clean water, and dry with a soft cloth, previously warmed. Coat one side of the plate with the following gelatine solution, applied in the same manner as collodion.

Gelatine Solution.—20 grains Nelson's patent gelatine, dissolved in 10 oz. of water, and ½ oz. spirits of wine. Filter. After coating the plate, pour back the superfluous gelatine into the bottle, stand the plate to drain on a piece of blotting paper, when dry, warm slightly, and pack in a grooved box. A number of plates may be thus coated at one time, as if they are carefully packed they will keep any length of time. Do not let any of the gelatine solution get on the back of the plate. Coat the plate with old iodized collodion in the usual way, and place in a similar nitrate of silver bath to that used in the wet collodion process, in which it must remain 4 or 5 minutes. Then wash with plenty of water.

Tannin Preserving Bath.—To every ounce distilled water required in the bath, add 15 grains tannin. Filter. Pour out two separate portions of about 4 drams each, one to be used for the first coating of the plate, which removes the water remaining on it after washing; the second portion is then poured on and off the sensitized side of the plate several times. Stand the plate in a warm dark room resting on blotting paper; when dry, it is ready for use in the camera. The necessary time for exposure varies from one minute on a very favourable day, to eight minutes in dull weather.

Developing Solutions.—1. 72 grains pyrogallic acid in 1 oz. spirits of wine; keep in a stoppered bottle. 2. 20 grains each of nitrate of silver and citric acid, dissolved in 1 oz. distilled water. Filter. Add ½ dram of No. 1 to 3 oz. distilled water, then take say 3 drams of this diluted pyrogallic solution, and add to it from 10 to 15 minims of the nitrate of silver and acid solution, moisten the exposed plate with water, quickly and evenly applied, then pour on the developing solution, and let it flow gently to and fro over the plate. If the sky comes out quickly and strongly, but the details do not, it is a proof of under-exposure, which a little more pyrogallic acid added to the developer will remedy. If, however, the picture appears to come out at once, a proof of over-exposure, add a few drops of No. 2 solution to the developer. When developed fix with hyposulphite of soda, wash and varnish, as described for wet collodion.

ENLARGEMENT OF NEGATIVES.—The negative to be enlarged must be absolutely perfect as regards definition, slightly dense, and full of detail, possessing as little granularity as possible. From the negative, either by contact printing on a dry plate, or copied by the wet process in camera, a transparency should be obtained, the development to be effected by the application of a weak solution of

pyrogallic acid, to which a few drops of an acid solution of nitrate of silver, 10 grains to the oz., has been added. The contrasts should not be too decided, nor the shadows too dense. From such transparency the enlargement may be produced by the usual studio process up to six or eight diameters without any visible diminution in the excellency of its definition; or the transparency may be enlarged to the required size at once, and a negative obtained from it on a dry plate as before, or upon carbon tissue, each of which possesses its advantages.

Stereoscopic Views.—The appearance of high relief given by the stereoscope, is obtained by placing side by side two prints representing the same object, but photographed from slightly different positions, whilst the glass prisms of the stereoscope so direct the visual rays as to superpose the views, and but one picture is seen, although it is in reality a combination of both; thus the same object is seen from two different points of view at the same time, as is always the case when both eyes are looking at one thing, as they, with the object seen, of course form a kind of triangle. Views for the stereoscope are frequently taken simultaneously by two cameras, placed at certain angles and distances from each other, varying with the size and distance of the object to be photographed; but for portraits less trouble is involved by the use of a properly constructed twin camera. For views, or groups, situated some distance from the operator, two distinct cameras must be used (or one camera moved from place to place); the distance they must be placed apart, and the relative angle in which they should stand to each other, require careful consideration. For portraits or other objects, to which the cameras can be brought rather close, the angle should not be too great, otherwise the effect of relief will be distorted. In such cases an angle of about 2° must be used. For landscapes, as large an angle as 4° may generally be safely employed. To reckon the angles, suppose the nearest point of the view to be taken to represent the apex of a triangle, from each camera produce an imaginary straight line to the apex, these lines must represent the desired angle. As lines diverging from a centre may be indefinitely produced without altering their relative angle to each other, so the distance between the cameras will not affect the angles they should stand in, except that, for pictorial effect, distant objects may be a little distorted with good results, as will be the case when a large angle is used; whereas for subjects close to the camera, such distortion does not give a pleasing picture. Supposing an angle of 2° to be used, the distance required between the cameras will be about $1\frac{1}{4}$ in. for 1 yard, $2\frac{1}{2}$ in. for 2 yards, $3\frac{3}{4}$ in. for 3 yards, 5 in. for 4 yards, 6 in. for 5 yards, $7\frac{1}{2}$ in. for 6 yards, 9 in. for 7 yards, 10 in. for 8 yards, $11\frac{1}{3}$ in. for 9 yards, $12\frac{1}{2}$ in. for 10 yards, 19 in. for 15 yards, 25 in. for 20 yards. These remarks apply equally whether two cameras are used simultaneously, or whether only one camera is used, being moved from one position to the other as required.

Twin Lens Camera.—This is a camera having two double achromatic combinations of the same focal length, in other respects like an ordinary camera, except that it has two folding shutters at the back. Before focussing the object to be photographed, it is necessary to ascertain that the two lenses are in focus with each other. For this purpose, focus a statuette, or other convenient article, and when a perfectly sharp image is obtained with each of the lenses, upon the ground-glass slide, do not again alter the rack and pinion which adjust the lenses; any further adjustment necessary for portraits to be taken subsequently must be obtained by drawing in or out the expanding body of the camera, as when once the glasses are of the exact focal length, their relative positions to each other will not require any alteration, although the body of the camera will. As the two lenses are necessarily rather close to each other, the twin camera will only answer for photographs taken at a very short distance, otherwise the effect of relief will not be

obtained. The glasses used are longer than they are wide, as two negatives are taken at the same time. All the operations are the same as before described for negatives; when the positive prints are obtained, their position must be reversed in mounting, the left-hand half of the print being pasted on the right-hand side of the card, and the right side of the print on the left side of the card.

Stereoscopic Views with One Ordinary Camera.—The camera must be placed on a board, having a movable slip of wood at each side which can be adjusted to the desired angle, against which the camera must be placed, first on one side to take one view, and then on the other side to take the other view. Mark cross lines on the ground-glass plate, to intersect a central point of the view from whichever side of the board the camera is standing; this is to ensure correct centres for the proofs. Two separate negatives are then taken; when mounting the prints, transpose their position from right to left. Dark slides are made for this process, to hold a glass sufficiently long to contain both views, and fitted with two shutters, by which each half of the glass can be exposed alternately. Having exposed the right-hand half, close its shutter, move the camera the required distance to the left, and expose the left-hand half of the glass.

Stereoscopic Views with Two Ordinary Cameras.—For instantaneous views of any landscape containing animate figures, it is necessary to use two quarter-plate cameras, with lenses of exactly equal focal length; they must be placed on a board provided with movable stops to regulate angle and distance. Great care is necessary in manipulation; the two shutters must be opened and closed at the same time, otherwise the two proofs will develop unequally. The plates should be collodionized and sensitized in the same baths, and to the same extent. For the developing bath, employ a vessel into which the two plates can be placed side by side, so that the same pyrogallic acid may effect both simultaneously. When mounting the positives, transpose the two views, left to right, as before described.

Photography by Artificial Light.—Negatives may be obtained by the aid of light given by burning magnesium wire, care being taken that the direct light does not fall on the lens, and that the object is well illuminated. Transparent positives on glass may be printed by the light of a gas-burner, or of an argand oil lamp.

Transparent Positives.—These are taken from negatives, and may be obtained of the same size, or larger, or smaller than the original, as desired. For copies of the same size as the negative, the operation can be effected by placing the negative in a printing frame, in contact with an ordinary dry collodion plate. The negative used should be very clear in the lights, and have transparent shades. To obtain a good negative for this process use a more acid nitrate of silver bath than for ordinary negatives, and do not continue the development so long. By daylight the exposure required will be a few seconds, but gaslight may also be used, when the exposure must be extended over several minutes. In developing, pyrogallic and citric acid give a blue-black tint; pyrogallic and acetic acid a brown-black tint. If intended to be hung up as a transparency, varnish and protect the collodion side with a ground-glass backing, bind round the edges to keep out dust. If the transparency is required of a different size to the negative, the camera and lens must be used. One means of doing this is to work in a dark room, allow the light to enter through the negative only, and proceed as usual with the exposure and developing.

Copying Camera.—This is a kind of double-bodied camera, one part of which is provided with holders for the negatives, and has no lens; the other portion has a lens which can be moved so as to approach or recede from the negative, and has the usual ground-glass plate. The negative must be placed in its holder, screw on the lens, and adjust

the lens to its proper distance from the negative. If the copy is wished to be larger than the negative, approach the lens to it, and farther from the ground glass; if it is required to be smaller, remove the negative farther from the lens. The light passing through the negative will show its image on the ground glass in the usual way. When the desired size is obtained, remove the ground glass, and replace by a frame having an ordinary wet sensitized plate. Use a diaphragm, with a small stop, and proceed as if for an ordinary negative. It is necessary sometimes, when considerable enlargements are required, to use a camera with a long body opening out like an accordion; the operations are similar when once the proper focal distances have been adjusted. The power of a lens is determined by its shape and diameter. The larger it is in diameter, the more light it will admit; whilst the degree of curvature it has regulates its focal length, and determines the size of the image it will produce. It is the focal length of a lens, and not its diameter, which regulates the size of the image, and the distance it has to be from the ground-glass screen determines the length of body required in the copying camera.

To calculate Length of Camera required.— Calculate the distance the ground glass must be from the back lens thus; multiply the focal length of the lens used by the number of times of enlargement required, add the focal length to the product. The focus of a quarter-plate lens is generally 6 in. Say the negative is to be enlarged 3 times, $6 \times 3 = 18 + 6$ in. focal length $= 24$ in., the distance required between the ground glass and the lens. The distance the negative is to be in front of the lens is always more than the focal length, but less than twice the focal length.

MAGIC-LANTERN SLIDES.—If the transparent positives obtained are intended for the magic lantern, they need not be varnished; if varnish is used, the crystal varnish is better adapted for the purpose than spirit varnish, which would probably show streaks when magnified on the screen. Mount on another piece of glass of the same size to protect the collodion film, and bind round the edges like a passe-partout.

The Solar Camera.—This is a copying camera with a condensing lens to concentrate the sun's light on the negative, so as to allow the focus of the lens to be at a considerable distance, to obtain an enlargement of a picture. The magnified image of the transparent negative may be received upon either sensitized glass or paper. For use with ordinary albumenized paper, sensitize it in the usual way; the development required will however be longer. Or thin Saxony paper may be used, after being floated for one minute on the following solution;—chloride of ammonium and citric acid, 4 drams each; 25 oz. of distilled water, saturated with sesquicarbonate of soda. To prepare this bath, dissolve the citric acid in part of the water, and add the soda until the acid is neutralized; add the resulting citrate of soda to the solution of chloride of ammonium; add a little citric acid in solution, with a small quantity of boiled arrowroot. Remove the paper from this bath, and hang to dry.

Sensitizing Bath.—Nitrate of silver, 1 oz., in 18 oz. distilled water; add a few drops of citric acid to dissolve the first precipitate. Lay the paper on this solution, prepared side downwards, for half a minute, dry in a dark room. Expose the paper until it takes a pale lilac tinge, which will occur in a few minutes, remove and immerse in the following.

Developing Bath.—Dissolve 15 grains gallic acid in 1 dram alcohol; and $7\frac{1}{2}$ grains acetate of lead in $1\frac{1}{2}$ oz. water. Pour these solutions into 5 pints of water, adding a few drops of glacial acetic acid to redissolve the slight precipitate which will form. Several prints may be developed at once; when developed, remove and wash in clean water.

Fixing.—6 oz. of hydrosulphite of soda dissolved in 1 pint water. Leave the prints in the bath for about four minutes, then wash very thoroughly in

running water, and dry. The negative to be copied should be a weak glass picture, with plenty of detail in the shadows, and not too dense in the bright lights. An ordinary negative is too opaque to produce a good result. Choose a sunny day, and turn the mirror of the camera so that it reflects the sun's light on the condensing lens.

Photo-lithography. — To produce a photo-lithographic impression of a negative proceed as follows;—Procure a solution of gelatine to which is added a small quantity of albumen in combination with a solution of bichromate of potash, and in a warm state spread it on a sheet of fine-textured paper with a flat brush in a room partially darkened, and hang it up to dry, excluding it from light. The negative or glass picture having been placed in a photographic copying frame, place over the negative the prepared paper, over that a piece of fine woollen cloth, and screw all in the frame together, and expose the copying frame and negative to diffused light for 10 or 15 minutes; the light passes through the transparent parts of the negative on to the paper, which, by the chemical action of the light on the chromatized paper, will affect it, turning it from a yellow colour to a deep brown, while the part of the negative which intercepts the light is not chemically acted upon in consequence of the absence of light, and remains light yellow. When removed into a darkened chamber, and the chromatized gelatinized paper examined, a perfect brown impression will be seen impressed thereon. The next operation is to cover the whole surface of the page with lithographic transfer ink, evenly, and reduce in quantity by wiping it off with a fine rag, then lay by for an hour or so. The principle involved by the action of light is to render the chromatized gelatine, when acted on by it, insoluble in warm water; therefore, if the prepared paper be placed therein, it will not affect the brown shade of the impression, which is now covered with transfer ink, but all the rest will immediately wash away, leaving a perfect impression of the picture on the paper in transfer ink; a suitably prepared lithographic stone or plate of zinc is put into a lithographic press, the stone or plate partially warmed, and the transfer, dry, is placed face on stone or plate and passed through the press slowly and with a good pressure, only once through, when on the removal, it will be found effectually transferred to stone or plate, and any reasonable number of copies can be struck off in printers' ink.

Nature Printing. — There are two methods employed for obtaining facsimiles of ferns, leaves, sea-weeds, one suited to the amateur, the other for commercial purposes. 1. For the former the requisites are small quantities of coloured printing inks, black may be used, but the natural colours look much better, a little cotton wool, and some pieces of very soft wash-leather. Either fresh or dried leaves may be used; the former require no preparation, the latter should be dipped in water, and then left between damp blotting paper for some time to become tough, or they sometimes crumble to pieces during the manipulation. A dabber about the size of a marble is made of cotton and soft leather tied up, a small quantity of ink of the desired colour put on a piece of glass, and the dabber covered with it, using as little as possible. The side of the leaf from which the impression is to be taken is then laid, face upwards, on a piece of clean paper, and the dabber employed lightly to coat all the prominent parts of the leaf with the ink. The leaf is then laid, ink side downwards, on a piece of moistened paper, covered with another similar piece, which may be kept in place by lead weights if necessary. The part under which the leaf remains should then be carefully pressed with a dabber, similar to that used for the ink, taking care to go steadily and evenly over the whole surface of the leaf. Of course it is necessary to take great care to prevent the leaf or paper from shifting. Any number of impressions may be taken from one leaf. Inks may be mixed with a small palette knife to obtain any shade of colour, and two

or more colours may be used on one specimen. 2. In the commercial process, the leaf, or other object, is placed on a steel plate, and covered with a lead plate scraped bright; it is then subjected to great pressure, which leaves a beautiful impression on the lead. From this a copper matrix is taken by the electrotype, which in turn serves to produce an intaglio plate in copper, from which impressions may be taken in the usual manner. 3. A piece of writing paper is moistened with olive oil and thoroughly smoked over the flame of a tallow candle, the leaf, which should be dry, is laid upon it covered with a piece of paper, and well dabbed all over, then transferred to a piece of clean paper and the dabbing repeated, when it will leave an impression much like a very delicate pencil drawing.

Photography on Silk.—Pour 20 oz. of boiling water on 100 grains of chloride of ammonium and 60 grains of Iceland moss. When nearly cold, filter, and immerse the silk in it for 15 minutes. To sensitize, immerse the silk in a 20-grain solution of nitrate of silver for 16 minutes. Let the nitrate bath be rather acid. When dry, prepare for printing by attaching the silk to a piece of cardboard a little smaller than itself, by turning the edges over and fastening with small pieces of gummed paper. Slightly over-print. Wash in two or three changes of water, and tone in a gold bath made thus;—29 oz. of water, 2 drams acetate of soda, 4 grains chloride of gold, and a few grains of common whiting. Filter and keep for 24 hours before using. Let the prints be toned slightly bluer than they are required to be when finished. Rinse them in water, and fix in a solution of hypo., 4 oz. to the pint of water; 20 minutes is ample time for fixing. Wash well.

Photography for Wood-engraving.—It is easy to obtain a photograph on the wood; but the nitrate of silver disorganizes it, and renders it unfit for the purpose intended. If varnish is used to protect the wood, the engraver can scarcely operate upon it. These difficulties appear to be obviated by the use of the Worthleytype process—uranium collodion containing so little nitrate of silver as to produce no injurious effect. If desired, when the picture is printed on the block, the collodion may be removed by means of cotton moistened with ether, and an excellent image will be seen on the surface of the wood, which is then in as fit a state for engraving as if the drawing had been made in the usual way. Ivory may be treated in a similar manner.

To Reduce Old Baths and Nitrate of Silver Solutions.—Filter the solution of silver proposed to be operated upon until it is clear, and place the filtrate into a clean white bottle of suitable capacity. To each pint of the liquid add 4 oz. or more of mercury, and allow the mixture to remain at perfect rest for a few days. In a very few hours a beautiful sparkling coruscation will be found forming upon the surface of the mercury by what is known as double elective affinity, and for each atom of the silver so deposited, a corresponding amount of mercury is acted upon by the nitric acid of the silver, and passes into solution as nitrate of mercury. The deposition continues until all the silver has been thrown down, when we find over it a strong solution of the nitrate of mercury, which may be obtained in the solid crystalline form by evaporation. In a few days the deposition will be completed, which can be readily seen if the tree ceases to grow. Shake the bottle thoroughly, so that the branches of the tree are detached and broken, and brought in thorough contact with the mercury, where the spangles of silver are quickly dissolved. The watery part of the mixture can now be drawn or decanted off from the mercury, and the latter placed in a bag, or, better, in a large piece of fine tough buckskin, and pressed with force between the hands. When no more mercury can be squeezed through, the bag may be opened and the lump of brittle amalgam removed, and preserved in a well-cleaned and stoppered bottle until more has been accumulated. In case all the mercury should disappear at the end of the process, a

little more may be added to the watery solution to ascertain whether it still contains silver.

BACKGROUND.—Wet the canvas you intend for background and wring out well, then tack tightly as possible on to a frame, say 7 ft. 6 in. by 5 ft. When dry, paint over with the following;—white lead, 1 lb.; driers, 2 oz.; black paint, sufficient to give it the desired shade; turpentine, half pint. Mix thoroughly, and allow to stand a day, when the lead will settle down. Pour off turps carefully, which will rid it of the oil; bring to proper consistency by adding fresh turps. Then add 1 oz. scraped yellow soap, strain through calico, and it is ready for use. The quicker it is brushed over the canvas the better. If done over again it will be improved.

CLEANING OLD VARNISHED NEGATIVES.—These can be cleaned by boiling them a few minutes in a strong solution of soda, wash thoroughly in several changes of water, and wipe dry. Or, when few in number, add to 10 oz. old collodion, 1 dram sulphuric acid, pour over the varnished side, drain slightly, and place another plate face downwards upon it; let them remain in contact about 20 minutes, soak an hour in water, wash well, and wipe dry for use.

Blue Pictures, or the Cyanotype Process.—Ammonia-citrate of iron, 40 grains; distilled water, 1 oz. Spread evenly over the paper, by means of a flat brush or a glass rod, the above solution. Allow to dry. Expose to light under the negative for a few minutes in the sun, or from half an hour to one hour in the shade, depending on the intensity of the light. Spread over the paper, in the same manner as above, the following;—ferro-cyanide of potassium, 1 dram; water, 1 oz., which immediately on being applied becomes of a blue colour. Allow to remain a few minutes, then wash in water, and a blue positive picture will be the result. To prevent the picture fading, apply a solution of carbonate of ammonia, which turns the picture of a lavender colour; then wash in water and dry, when the blue colour will be restored. If the picture has not been exposed long enough, it will be very faint.

Magic Photographic Pictures.—In the first place an ordinary print must be taken on albumen paper from a negative in the usual manner. When it is sufficiently printed it must be carefully washed in the dark room, so as to remove all free nitrate of silver. Now take it into the dark room and immerse it in the following solution;—saturated solution of bichloride of mercury, 1 oz.; hydrochloric acid, 1 dram. The saturated solution of bichloride of mercury is best prepared by dissolving the solid bichloride in hot water, as much as it will dissolve, then allowing the solution to cool, and pouring off the clear portion for use. The salt that crystallizes out can be preserved for future use. Bichloride of mercury is a violent poison. The print will bleach in this liquid and disappear, from the formation of new and colourless compounds. When the paper appears quite white and colourless it is removed from the bath of bichloride solution, and well washed and dried in the dark room.

Development of the Magic Picture.—Make a saturated solution of hyposulphite of soda, and steep pieces of blotting paper of the same size as the prints which are to be developed in the solution, and dry them for use. Place the whitened picture on a piece of glass, albumen side upward, lay a piece of the blotting paper on this, and moisten it thoroughly with water, and place another piece of glass upon the blotting paper, press closely together by means of a weight or press; in a very short time the picture is restored in all its original detail, and now of a sepia colour.

TO OBTAIN THE GOLD FROM AN OLD TONING BATH.—Add sulphate of iron, either in crystals or solution, to the toning bath. The sulphate of iron will precipitate the gold in a black powder, which can be dried after well washing in several waters, and dissolved in nitro-muriatic acid, when a solution of chloride of gold will be obtained, which can be

evaporated to dryness, after which it should be dissolved in distilled water, and again evaporated so as to get rid of the acid. Another way is to reduce the black powder in a crucible, but an enormous heat would be required. As an alternative to either of the above methods, the residue or black powder may be sent to the smelters, who would undertake to reduce it and allow cash for the same.

Silver from Trimmings of Untoned Prints.—Procure an old iron bucket or pot, and place the cuttings in a few handfuls at a time, and apply a light to them, when they will quickly burn to ashes. As they burn down keep adding the cuttings, which must be stirred up frequently with an iron rod, so as to completely reduce all the mass to fine ashes. Of course the burning must be done out of doors, owing to the dense smoke and disagreeable fumes. If in windy weather, place a piece of sheet iron partly over the bucket to prevent the ashes from blowing away. The fire will be a long time dying out. After the trimmings are reduced to ashes, the ashes can then be reduced to metallic silver in a crucible with equal quantities of carbonate of soda and borax, or sent away to be reduced.

Chloride of Silver from Washing of Prints.—This can be reduced to metallic silver in the same way as the ashes from the trimmings.

To Reduce Nitrate of Silver Bath.—Throw the old baths into the washing waters and convert into chloride of silver, adding common salt till the water ceases to look milky. Or evaporate to dryness, redissolve, and use for printing bath.

To Intensify Negatives after they are Varnished.—When a negative has been varnished, it sometimes becomes so weakened as to cause great disappointment. But a negative need not be given up as hopeless under these circumstances. Make a negative intensifying varnish by adding tincture of iodine—alcohol, 1 oz.; iodine, 10 grains—to any good negative spirit varnish, until of a very deep sherry colour. Label the bottle, and keep for special use. When a negative prints weak and without sufficient contrast, revarnish with this varnish; pour on in the usual manner, allowing a few seconds for the yellow varnish to penetrate the film, and dry by heat in the usual manner of varnishing the plate. The negative will be found to be changed to a more non-actinic colour that will take longer to print, and will produce a more brilliant impression on paper. Many weak, thin, foggy negatives may thus be made to produce passable prints. It is well to keep two varieties of this yellow varnish; one of an ordinary sherry colour for negatives that only want a little intensifying; and another with a very deep port-wine colour—made by adding a greater quantity of tincture of iodine—and using this latter for negatives that are very weak and grey. A varnish of this character may also be used with advantage for varnishing the plate in the first instance, if the negative is found to be not quite intense enough, as the iodine in the varnish unites with the silver deposit, thus increasing the intensity of the negative. It is scarcely necessary to say that these expedients, though useful in cases of extremity, should never be used as a regular practice.

On Reducing the Intensity of Negatives.—When a negative is too dense, and it is wished to reduce the intensity, the usual recommendation is to employ a strong solution of cyanide of potassium to dissolve away the excess of density. This method is effectual when there is an excess of deposit all over the plate, and where the deep shadows will bear reducing, as well as the high lights. When, however, the density is in excess only on the high lights, and the deep shades are already too bare, this method is not only not useful, but is mischievous. By the use of perchloride of iron such negatives may be materially improved and rendered capable of producing satisfactory prints. Make a stock solution of 30 grains of perchloride of iron to the ounce of water. When a negative has been fixed and washed, and is found too dense in the

high lights, take a few drops of the solution and dilute until it has only a pale golden tint. Flow over the negative, or pour on to any part where the intensity is wished to be reduced. The solution acts immediately, according to the strength, making the deposit rather duller in colour. Wash well; no difference will be perceived except the slight dulness. The ordinary fixing solution, hypo. or cyanide, has now to be poured over the plate, and according to the action of the perchloride, so will be the reduction of the density. Where the silver is most abundant on the negative, there the perchloride most readily acts, and this constitutes its most useful peculiarity. It requires most carefully using, or the greater part of the deposit will be changed into chloride of silver, and be soluble in the fixing bath. It is best to experiment on a waste plate or two before trying it on a valuable negative. If the negative is not enough reduced by the first application of the perchloride and fixing solutions, the action may be repeated again and again, until just the desired amount of deposit is left. The perchloride solution should be used very dilute, scarcely coloured; it has no tendency to stain, nor eat away the weakest half-tones. The fixing solution acts immediately. All that it dissolves it does at once, so that but little time is lost. A good washing is required after the hypo. or cyanide, but the perchloride is rapidly washed away. Everything may be done in open daylight.

To Remove Silver Stains from the Hands.—1. Wash the hands well in hot water with soap, then rub the stain with a flat piece of pumice-stone; the greater part of the stain may thus be removed. Finish with a piece of cyanide of potassium, by rubbing the hand, while still wet, on the stained part, and the stain will disappear. 2. Wash in a saturated solution of hyposulphite of soda, kept for the purpose. Then wash with plain soap and water, and a little powdered pumice-stone. 3. Keep a saturated solution of cyanide of potassium in one bottle, and a solution, 10 grains to the ounce, of iodide of potassium, to which has been added as much iodine as it will dissolve, in another bottle. Touch the stain first with the iodide solution, wash, and then use the cyanide, rubbing it on the yellow stains. Cyanide must never be used to the hands when the skin is cut, or in any way injured, as pain and danger may result from the absorption of the poison.

Removing Silver Stains from Linen.—Stains should always be removed from linen before it is sent to be washed. Wet the part stained, and put on a few drops of a saturated solution of cyanide, or rub it with a solid lump; if the mark does not quickly disappear, wash, and put on a drop or two of the iodine solution mentioned in the preceding paragraph; the stain will change colour, and a little cyanide will dissolve it. When the linen is double, and the stain goes through, the solutions must be applied to each side.

Removing Yellow Iron Stains from Linen.—Yellow stains, commonly called ironmould, are removed by hydrochloric acid, or hot solution of oxalic acid, washing well in warm water afterwards.

Iron Developer to Produce Dense Negatives.—When nearly the right amount of intensity is supplied by the iron in the first instance, the plan of giving a little increased density to the high lights of a negative by pyrogallic and silver is a very satisfactory mode of working; but when the original deposit is thin, grey, and metallic, then is felt the shortcomings of the iron developer; for not only does the image require a great addition of strength, but it also unwillingly takes the intensity. Under these conditions the picture requires several applications of the pyro. and silver; and when the required density is produced, there is usually found a considerable loss of delicacy. The more forcing the image requires to become dense, the less satisfactory is the result. This defect, the absence of primary intensity, is chiefly found in working in the open air, where the sky forms a large portion of the picture; or in

using samples of collodion containing a large degree of bromide; in copying some kinds of pictures; in using a collodion giving only a thin and blue film; and in using weak nitrate baths. Gelatine added to the iron developer appears to act beneficially by the increased glutinous properties it gives to the solution, it seems to flow more steadily and certainly over the collodion surface, so that, not hesitating or running into irregular lines, it does not cause the stains and markings that it otherwise is prone to. By this means the developer may be poured on more deliberately, and less solution will be required for the plate; the quantity of nitrate of silver thus becomes less diluted; and from this cause it tends to produce a more dense picture. There are several ways in which gelatine may be added to the iron developer. 1. Mix 1 oz., by measure, of ordinary sulphuric acid with 1 oz. of water; let them cool. Then add 120 grains of gelatine; when dissolved, add say 5 oz. of water, and neutralize with ordinary ammonia. Add 1 oz. of glacial acetic acid, and make up the total quantity to 20 oz. of solution. To form a developer, prepare a 20-grain solution of protosulphate of iron, and add to each ounce from 10 minims to 1 or even 2 drams of the above sulphuro-gelatine mixture, according to the intensity desired, remembering that the intensity will be just in proportion to the quantity of the mixture added. 2. Glacial acetic acid, 2 oz.; distilled water, 8 oz.; Nelson's gelatine, 120 grains. Mix these together, and in a short time the gelatine will dissolve. Then add to it—distilled water, 70 oz.; protosulphate of iron, 2. This developing solution does not keep very well, and should not be made in large quantities. In cold weather it is apt to gelatinize, but a little warmth sets it all right. This solution flows like oil on the plate, readily mixing with the free nitrate, and has little tendency to form stains and streaks. The image comes out slowly and steadily, and not with a flash. The high lights, if the exposure be rightly timed, will be found to have nearly or quite the right density by the time the detail is out. If not sufficiently dense when fully developed, the solution may be poured on and off, and the density will increase; or a little fresh solution may be taken, to which a few drops of silver have been added, and any amount of intensity may be obtained. The images dry intense, and are not much reduced in varnishing.

Varieties of the Iron Developer.—The amount of alcohol necessary in the developer depends on the condition of the nitrate bath. The more acetic acid present, or the newer the nitrate bath, the less the need of alcohol, but for general use half a dram of alcohol to each ounce of developer is a useful proportion. 1. Iron, 20 grains; acetate of soda, 6 grains; glacial acetic acid, 20 minims; water, 1 oz. 2. Iron, 2 oz.; formic acid, 1½ oz.; sulphuric acid, 5 minims; water, 16½ oz. 3. Iron, 15 to 20 grains; loaf sugar, 50 grains; glacial acetic acid, 10 minims; water, 1 oz. 4. Iron, ½ oz.; Epsom salts, 1 oz.; glacial acetic acid, ½ oz.; water, 16 oz.

Opalotype Pictures.—Any method for producing glass transparencies will also serve for these pictures, only the printing should not be carried so far.

Opalotypes by the Wet Process.—It is only necessary to use opal glass instead of patent plate, and all the directions given for transparencies for windows exactly apply. Should the colour of the picture not be agreeable, it may be toned with gold by any of the usual processes, taking care to use the solution about one quarter the ordinary strength.

Opalotypes by the Dry Method.—Any of the dry processes may be employed, and the plate may be used, either in the camera, or by direct contact in the printing frame. The development may be conducted the same as for a transparency, and, after fixing, may be toned the same as by the wet process.

Opalotype by Collodio-Chloride.—The ordinary method of producing opal pictures is by collodio-chloride, which is sold with full instructions for use. The plate, when coated with this preparation and dried, is ready to be used in the

printing frame, and may be printed, fixed, and toned, just as a paper print, except that no more washing will be required than for a ordinary negative. The use of opal glass as a material to print upon is recommended, as pictures of greater beauty are yielded than can be produced on paper.

Cabinet Portraits.—The same treatment should be used in producing these pictures as in cartes; but a different lens will be necessary, as those used for the cartes are too short in focus. A half or whole plate lens, or one made expressly, will answer best. The adopted size of the cabinet portraits is as follows,—Size of mounted picture, $5\frac{1}{2}$ in. by 4 in.; mounting card, $6\frac{1}{2}$ in. by $4\frac{1}{4}$ in.; opening in album, $5\frac{1}{4}$ in. by $3\frac{7}{8}$ in.

Effects of Weather and Temperature.—During an easterly wind, double or treble the exposure is necessary in outdoor work. The window of the dark room will require to be re-yellowed in the spring; chemical darkness sufficient in the winter sun, will be insufficient in spring and summer. An even temperature should be kept in the studio all the year round; in cold weather all the operations are tediously prolonged, unless the rooms are artificially warmed.

PHOTOGRAPHIC NEWS-LETTERS.—To procure these minute photographs, an ordinary negative must be taken, great care being necessary to obtain a negative that is perfectly clear at the edges, as well as in the centre. This operation will produce a photograph as much smaller than the original as the power of the lens and length of focus will allow. From a print taken off the negative thus obtained, another negative still more reduced must be taken, and this operation repeated if necessary until the final photograph is obtained of the desired size. The last positive must be printed on very fine transparent paper, and all the usual operations for toning and fixing carefully performed. On arriving at its destination the letter must be carefully unrolled and mounted on glass, then by the aid of a gas microscope attached to a powerful phantasmagoria lantern the image can be reflected on to a screen, and will be so much magnified as to be easily read and transcribed. If rapidity of copying is desired, the image on the screen may be divided into portions by lines, and several persons set to copy at the same time.

Photo-micrographs, or Photographs for Microscopic Slides.—The lens being removed from an ordinary $\frac{1}{4}$-plate camera, a mahogany cone, blackened inside, and about 2 in. in depth, is substituted, made to fit tightly into the flange of the camera, and having an opening at the apex through which the tube of the microscope can just pass freely, and only just, and to which an india-rubber band very slightly smaller than the tube of the microscope should be glued, to prevent light entering between the microscope and the cone. The microscope is then placed in a horizontal position, and the eye-piece having been taken out, the tube is passed through the cone and the eye-piece replaced. The object to be photographed, which should be as transparent as possible, is then secured on the stage of the microscope, the manner of doing which, when the stage is vertical, varies with the construction of the microscope. This may be done with two small slips of wood $3\frac{1}{2}$ in. by $\frac{1}{4}$ in. under the stage, one on each side of the opening, and two small india-rubber bands slipped over the ends of both wood and slide. The object can then be focussed on the ground-glass screen, but as the microscope is not specially constructed for the purpose, the chemical and visual foci do not coincide, and the chemical focus must be found by experiment. A few trials, using the fine adjustment, will give the requisite difference between the two foci, which, once found, is constant. A strong light must be employed, but not direct sunlight. The light from a white cloud on a bright day is the best illuminator. No special collodion or developer need be used, beyond being of the best, a necessary point in every photographic operation. The exposure will, of course, vary with the intensity of the light, quality of the lenses of the microscope, sensitiveness of the plate, &c. It should, however, be

short, as the image is very bright with a good microscope. If there are many to do, it will be found advantageous to contrive an arrangement of both microscope and camera on a board which can be screwed to the camera stand. Some operators prefer to work without the eye-piece of the microscope, but there is then sometimes an objectionable flare in the centre of the picture. The eye-piece occasions some little loss of light, and therefore it would be preferable to work without it if possible.

Gilding. — Wood, leather, paper, and similar substances, are gilt by fastening on leaves of gold by means of some cement; metals are gilt chiefly by amalgamation, or by the action of galvanism. The necessary materials are a cushion, knife, and tip, a large, short and thick camel-hair brush, cotton-wool, and oil and japanners' size. Gold leaf is sold in books of 25 leaves, each about 3 in. square. It is reckoned by the hundred, that is, the contents of four books, and gilders calculate a work to require so many hundreds, not so many books. There are 13 varieties of tint, ranging from a deep orange red down to a white approximating silver. The cushion is a piece of wood about 8 in. by 5, covered first with baize, and then with buff leather tightly stitched. At one end there is a raised edge or screen of parchment, which turns partly round the sides. This is to prevent the leaves being blown away by any chance wind. Underneath, the cushion has two, and sometimes three small loops of leather, one for inserting the thumb to hold it by, the others for sticking the knife and camel-hair brush in. The knife for cutting the gold leaf has a long flexible blade, which should not be too sharp, set in a light handle like a palette knife. The knife must be always kept clean and bright. The tip is a large flat brush for taking up and placing the gold leaf. It is made of very long squirrel's hair, set thinly between the flat pieces of card. Cotton-wool and the thick camel-hair brush are used for dabbing down the gold and removing superfluous pieces. There are two kinds of gold size, fat oil and japanners' size. The former is the more durable and brilliant, so that japanners' size should never be employed except for mending small places and imperfections, or where time is of great importance. The gold from which gold leaf is made must be very pure; it is hammered out, after it has been rolled as thin as paper, by being put between the leaves of a book of parchment and extremely thin skins, called gold-beaters' skin; the book is then laid upon a block of marble, and beat with a heavy hammer. When the leaves of gold are extended to the full size of the book, they are divided, and each portion is placed between the leaves of another book, which is hammered as before. This process is continued till the requisite thinness is acquired. Pale leaf gold has a greenish yellow colour, and is an alloy of gold with silver. Dutch gold is copper leaf coloured yellow by the fumes of zinc. It is much cheaper than true gold leaf, and is very useful where large quantities of gilding are wanted in places where it can be defended from the weather, by being covered with varnish; it changes colour if exposed to moisture. Silver leaf is prepared in the same manner as that of gold, but is liable to tarnish, except it is well secured by varnish. If covered with a transparent yellow varnish, it has much the appearance of gold.

Oil Gilding on Wood.—The gilding on wood, called oil gold, cannot be burnished, and is always of the natural colour of unwrought gold. It has the advantage that it may be washed and cleaned with water, which burnished gold never can. It is often used for picture frames, parts of furniture, and mouldings of apartments; as it stands the weather, it is also employed for outdoor work. The surface to be gilded should first of all be rubbed smooth, if stone with pumice, if wood with Dutch rushes, if a very bright level effect is desired. After this it should have its priming of glue size, and two coats of oil paint and one of flatting. To enrich the colour of the gold, these last may be laid down in red

or yellow. White, however, is usually preferred, as the darker colour renders any imperfection in the gold-sizing more difficult to detect. When the last coat of paint is thoroughly dry, rub it over with wash leather, to render it smooth and free from dust or grit. If there are any patterns or figures which are to be left ungilded, they should be lightly pounced over with white to prevent the gold leaf adhering to them. Another way is to paint them over with the white of egg diluted with water. If any gold sticks to this, it can be easily washed or wiped off with a moistened handkerchief. When all is ready for sizing, strain sufficient size through muslin, and put some out on the palette, adding to it enough ochre or vermilion, mixed with oil alone, to colour. Then with a stiff hog-hair tool commence painting it on the surface, taking care to lay it on smoothly, and not too thick. If put on too thickly it runs, and leaves wrinkles in the gilding. Size always from left to right, beginning at the top of the surface, and working downwards. Move the brush lightly and firmly, mapping out the surface to be sized into several squares, and finishing and cross hatching each before proceeding onwards. If there are patterns to be left ungilded, carefully trace round their outline first with a sable pencil, and then fill in the interstices. When the whole surface is covered with size, give it a thorough inspection to make sure there is no faulty portion, and if there is, delicately touch in the size with a small pencil. When very perfect gilding is required, it should be sized twice, the first coat being allowed to dry thoroughly before the second is applied. In carved work, be careful to dip the brush down into the hollows of the carving. It is a good plan to size over-night, so as to gild in the morning. But all size does not dry alike, sometimes taking 12 to 24 or 30 hours before it is ready for the gold leaf; in damp weather or positions, always more than in dry. The readiness of the size can only be ascertained by the touch. If on being touched by the finger the surface daubs or comes off, it is not ready, and must be left; if it feels clammy and sticky, it is sufficiently matured. If too dry it must be sized again. The books of gold leaf should always be placed before a fire half an hour previous to use, in order to thoroughly dry the gold and make it more manageable. When all is ready, shake out several leaves upon the gold cushion, and blow them towards the parchment screen. Then carefully raise one leaf with the blade of the knife, and place it on the cushion, gently breathing on it to flatten it out. If it cockles up, work it about with the knife-blade until it lies flat. Then replace the knife in its loop under the cushion, and taking the tip, pass it lightly over your hair, thus acquiring sufficient greasiness to enable the gold to stick to it. Lay the hairy portion of the tip upon the gold leaf, and then raising it, apply it to the sized surface. As in sizing work from left to right be specially careful to let each leaf overlap slightly, so as to avoid gaps and spaces. Lay on whole leaves as far as the space allows, and then proceed to gild the curves and corners which need smaller pieces. Place a leaf flat and smooth on the cushion, and then taking the knife in the right hand, draw the edge easily and evenly along it with a gentle pressure. Divide the leaf into as many pieces as required, and lay on as before. When all the ground is complete, give a very careful inspection to make sure there are no portions ungilt, however small, and mend them at once. Next take a piece of cotton-wool, and gently dab or press the gold down all over, finally brushing off the superfluous pieces either with cotton-wool or the camel-hair brush. It is a good plan to stipple the gold with a large stiff hog-hair tool, quite dry and clean, as this gradually softens and removes the marks of joining and other little imperfections. Finally smooth the gold with a clean piece of wash-leather, and it is completed. With regard to gilding with japanners' size, the same instructions apply, except as to the time necessary to wait between sizing and gilding.

If japanners' size is used pure, it will be ready in from 20 to 30 minutes, but better gilding can be made by mixing one-third oil size with two-thirds of japanners' size. This will be ready in about 2 or 4 hours from the time of putting on. When all the gilding is finished, dilute one-third very clean and pure parchment size in two-thirds water, and brush it all over the surface of the gold to enrich and preserve it. If it is necessary to gild in a position much exposed to touch, as the base of a pillar, or string-courses, it is as well to give the gold a coat of mastic varnish thinned with turpentine. There are various processes which tend to enrich and vary the effect of gilding. Glazings of transparent colour are sometimes applied for the purpose of deadening its lustre. Raw sienna passed thinly over a sheet of gold gives it a leathery appearance. A good effect may be produced by stencilling a small diaper in umber, sienna, or Indian red, over gold, especially if there is foliage or arabesque work upon the gilding, as the small diaper affords an agreeable relief. This is the easiest mode of gilding; any other metallic leaves may be applied in a similar manner.

JAPANNERS' GILDING is where ornaments are drawn in gold upon japanned work, and is often seen in folding screens and cabinets. The ornaments are formed by a camel-hair pencil, with japanners' gold size, made by boiling linseed oil with gum anımi, and a little vermilion. When the size is nearly dry, gold powder or gold leaf is applied. In all cases where gold has been fixed on by means of linseed oil, it will bear being washed without coming off.

BURNISHED, OR WATER GILDING, will not bear being wetted, and is only fit for work to be always kept within doors. For this gilding the wood is first covered with 4 or 5 coats of whiting and size; and that the gilding should be perfect, it is necessary that there should be a sufficient body of whiting. When these are dry, they are laid over with a coat of gold size, made of Armenian bole, a little wax, and some parchment size. When the size is dry, a portion of the surface is wetted plentifully with clear water and a soft brush, and a leaf of gold is applied, so as almost to float on the water, when it instantly settles down and adheres to the size. Great care must be taken not to suffer any of the water to come over the gold, or a stain will be produced. When the whole is covered with gold leaf, the effect is what is called matt, or dead gold, and is the natural colour of gold not burnished. Such parts as are required to be burnished are rubbed over with a burnishing tool of agate. Ornaments executed partly matt, and partly burnished, have a very rich effect, which is seen in most picture frames. As already stated, burnished gilding cannot be cleaned with water, though oil gold may; but the matt portion of water gilding is so like oil gold, as not to be distinguished by an inexperienced eye; and it may be very desirable to know, in that case, by which of the two processes it has been executed, with a view to cleaning it when soiled by flies or otherwise. This may be ascertained by observing in some crack or crevice whether the gold is laid on a coat of whiting; and if there is no other method, a small scratch with a knife may be made in some unimportant part to ascertain the fact. On account of the impossibility of washing water gilding without injury, it is necessary to take great care to protect it from flies, or other causes of soiling it, by covering it over with very fine net. Frames executed in water gilding are sometimes required to be regilt; this cannot be done without taking off the whole of the whiting, and commencing the process again, which is expensive. When this is done, the frames may be either regilt in the water or in the oil manner; and as the last is much the cheapest, it is sometimes preferred, although it cannot be burnished.

Gilding Signs or Letters.—The following method is adapted for working in the open air, when the ordinary process with the cushion is rendered difficult if there is much wind to blow the gold leaf about. Take a sheet of tissue

paper and rub it over on one side only with a piece of white wax. This should be rubbed rather briskly over the surface of the tissue paper, which should be placed on something flat, so that the wax is spread evenly throughout. The paper which has thus been rubbed will possess a certain sticky quality, scarcely perceptible to the touch, but sufficient to cause the gold-leaf to adhere to it. After a whole sheet of paper has been waxed as described, it should be cut into squares a little larger than the leaves of the book of gold. The gold-leaf book must be opened and the waxed side of the tissue paper gently pressed upon the gold leaf with the hand. On removing the paper the gold leaf will be found attached to it. The gold leaf being thus secured upon the tissue paper, is ready for use. It is evident that the difficulty experienced through the thinness of the gold is by this means to a great extent overcome. The tissue paper may be used over and over again. It is supposed that the letters to be gilded have been written in the most suitable material, and that they are ready to receive the gold leaf. Take up the tissue paper and place it with the gilded side to the letters, and having rubbed the back lightly with the hand, the old will come off the paper and adhere firmly to the mordant with which the lettering has been written. By this method very little gold is wasted, as the tissue paper being semi-transparent, the gold leaf shows through it, and the operator can see where any portion of the gold adheres to the paper, and can accordingly place it on such portions of the work as it will best fit without an undue number of joinings, though by this process, if the gold leaf is good, not the slightest trace of joining is discernible. The gold leaf should be gently dabbed over with a pad of cotton-wool, which will smooth the surface of the gilt, and remove all superfluous pieces of gold leaf. As a newly-painted surface is sticky, if the gold leaf were to be applied to it, it would adhere to parts of the ground colour where the mordant had not touched and where the gold was not required. It is needful, therefore, before the letters or parts to be gilded are marked out, that the newly-painted surface should be dabbed over lightly with dry whiting; but care should be taken that the loose particles are dusted off by the gentle application of a silk handkerchief. If the ground is a dark one, this pouncing will so far lighten it, that the gilder will be able to distinguish any lines he may make with size, as the size will restore the ground to its original colour. But if the ground is a light one, the pouncing will not have this effect, and it becomes necessary to mix some kind of colour with the size to enable the gilder to make certain that he has thoroughly covered the portion to be gilded. For pouncing, put some powdered whiting in a small linen bag, tie it up tightly, and gently dab it over the parts to be pounced. The whiting is removed from the ground after the gold leaf is applied, by means of a damp chamois leather. The mordants for gilding are of different kinds. Picture-frame gilders generally use gilders' size, made of fat oil, in which yellow ochre has been ground. This is a good material for the sign-writer, but it is too thick for general adoption, especially in cold weather, when it is unmanageable with the sable pencil. In hot weather, however, it is not so thick, and may often be used with advantage. The gold leaf must not be applied to this size for at least 24 hours after its application, and it will remain tacky for 2 or 3 days. When the gilding has to be finished more rapidly, japanners' gold size is generally employed. The gold leaf may be laid on this in about half an hour after its application, as it dries very rapidly. Sometimes the gilder is compelled to prepare his work and put on the gold leaf a few minutes afterwards; in this case, gold size alone is used. But if an interval of a few hours is no object, it is customary to add oil varnish to the gold size, regulating the quantity according to the time at disposal. Linseed oil should not be mixed with gold size to retard its drying pro-

perties, because it is apt not only to destroy the adhesiveness of the size, but to sweat through and discolour the metallic leaf. A few drops of boiled oil may be added to the size occasionally, but as a general rule, varnish will be found preferable to the oils.

Burnished Gilding on Glass.—The gold used is the ordinary gold leaf. Procure some fine isinglass, and place about as much in a tea-cup as will cover a sixpenny piece, and then pour on it about half a cupful of boiling water, which will dissolve the isinglass. Before the water is cold add about as much spirits of wine as there is water in the cup; then strain the whole through a clean silk handkerchief, and the mordant is ready for use. The addition of the spirits of wine is most material, as without it the gilding cannot be satisfactorily accomplished. Whatever may be the design or lettering has to be executed on the glass; it must first be set out on a sheet of white paper, and painted with Brunswick black, so that it can be seen on the reverse side. This paper with the writing reversed should be fixed at the edges or corners to the glass, the writing, of course, appearing backwards. The glass having been thoroughly cleansed and rubbed with a silk handkerchief, the gilding may be commenced, the gold leaf being laid on the reverse side to that to which the paper is attached. It is usual to place the glass in a slanting position on an easel, the lines of lettering not being horizontal, or reading from left to right, but perpendicular, reading from top to bottom. The mordant is put on with a large soft camel-hair pencil, and the gold leaf is lifted from the cushion and placed on the mordant with a tip, after having been cut to the required dimensions. If the line of writing is less than 3 in. in height, it is advisable to gild the whole line, without paying any regard to the shapes of the letters, so that when the line is finished it will be a solid piece of gilding about the same height and length as the letters. The first piece of gold leaf should be placed at the beginning of the line, which is the top of the glass, and each succeeding piece below it, the different pieces just overlapping each other. It is necessary to be particular in this, for if the pieces of gold do not meet, the interstices will probably show when the work is completed, and will prevent the uniformity of burnish. For letters larger than 3 in. in height, the gilding may be made to cover each letter, leaving the spaces between untouched. As soon as this part of the gilding has been completed it should be left to dry in a warm room, or placed before the fire, in which case it will be dry in a few minutes. When the gilding is perfectly dry and bright, it should be rubbed over very gently with a piece of cotton-wool. This will heighten the burnish of the gold, and remove the loose pieces which do not adhere to the glass. After the gilding has been treated as described, a flat soft camel-hair brush charged with the isinglass size should be passed lightly over the work; but not worked to and fro, or it will remove the gold leaf. The size should be flowed on freely and rapidly, and if any small pieces have been omitted, no attempt should be made to retouch them while the size is wet. When it is dry the gilding will resume its brightness. In order to complete the burnish of the gold, sometimes hot water is poured over the gilding, and this not only washes out any little specks which may appear on the front of the gold, but enhances its brilliancy considerably. The hotter the water poured over the work, the brighter does the gilding become, but care must be taken, as beyond certain degrees of heat the water will break the glass. This was very common, but the hot-water bath now is often dispensed with, and the size coated over the gilding is applied hot. This method is not quite so effective but it is much safer. The whole of the gilding has now to be repeated. A second layer of gold leaf over the first is necessary to ensure a satisfactory result. The second coat of gold is put on with the isinglass size, the same as the first; and as it dries, the gilding viewed from the front of the

glass will present a rich and finished appearance. The loose pieces of gold should be removed as after the first coat, by means of cotton-wool gently rubbed over the work. Another coat of size made hot may now be applied, and the gilding is ready to be written upon. It is better to leave the gilding on for a day or two before writing upon it, because the isinglass does not get thoroughly hard, though to all appearance it is perfectly dry in an hour or two. If the gilding is left untouched for two or three months, the action of the spirits of wine will cause the gold leaf to adhere so firmly to the glass that it will be difficult to remove it by any amount of washing with water; whereas in the course of a few days after it is laid on, it may be readily removed by a damp sponge. There are several ways of transferring the outline of the writing to the gold. The most expeditious method is to rub some dry whiting over the front side of the writing, on the paper, place this over the gilding, face downwards, then go over the outline of the letters with a pointed stick or hard pencil. On removing the paper, it will be found that where the letters have been traced, the whiting has marked the gold. Having an outline of the writing or design, next paint the letters with a sable writing pencil, and the ordinary japan black used by coach painters. If on turning the glass round it should be seen that the japan black deadens the gilding, or is perceptible in any way on the front of the glass, another coat of size should be passed over the gold to prevent the black from coming through the gold leaf. When the japan black is hard, the superfluous gold must be washed off with a sponge and warm water. When the japan is dry, the edges of the letters may be cut sharp and true by passing a small chisel along a straight edge, so as to trim the writing and make the tops and bottoms perfectly regular. All the straight lines of the letters may be thus trimmed, but the curved ones must be perfected with a writing pencil. The softened coloured thicknesses added to the letters are painted with the ordinary oil colours thinned with boiled oil and turpentine, the latter being used sparingly. Three or more tints are generally mixed on the palette, with a separate pencil to each, and these are softened with a larger sable pencil, and the outer edges are cut up with a pointed stick guided by a straight-edge, whilst the colour is wet, and the superfluous colour is wiped off with a piece of rag. By this means a sharpness of outline is obtained which the most skilful writer would fail to get by the mere use of the pencil. The shadow is put on as soon as the thickness is dry, and not being softened down, quick drying colours may be employed.

Preparation and Gilding of Picture Frames.—Suppose that we have a plain picture frame; it is made by the joiner into a 12-feet length of moulding, and in that state it passes into the hands of the gilder. He first gives it a priming of hot size and whiting, called thin white. The whiting employed by the gilder is not the same as that used for domestic purposes, but is finer and more free from grit. The size employed is prepared by the gilder from parchment cuttings, or glove cuttings. The cuttings are well washed in water, and then boiled in a certain quantity of clean water, until the latter has a particular degree of adhesiveness, which can only be determined by experience; this is then poured off into a clean dry vessel, and allowed to cool. When about to be used, the grease at the top and the sediment at the bottom are cut off with a knife, the size is melted in an earthen pipkin, and a small quantity of finely-powdered whiting is mixed up with it. When the thin white is dry, all holes and irregularities in the moulding are filled up with putty. This putty is not the same as that employed by the glazier, but consists of whiting and size mixed to the consistence of putty. When the puttying is dry, a coating of thick white is laid on with a brush. This thick white differs from the thin white only in having a larger proportion of dry whiting mixed with a given amount of size, the consistence attained being rather thicker

than that of oil paint. When the first thick white is dry, another is laid on in the same manner, and, similarly, a third, a fourth, and a fifth, are laid on, all about equal in thickness, and each one being perfectly dry before the next is applied. As in laying on this large body of thick white, the fine squares, hollows, and fillets would be liable to be stopped up and lose all their clearness and sharpness, opening tools, consisting of crooks, chisels, and gouges, are drawn along the fine parts of the moulding, while the thick white is still wet; by which means the forms of the various mouldings are retained. This is still better effected by the double opening white, which consists of two thick whites; the one laid on almost immediately after the other, by which a thick soft coating covers the moulding. Hard stones, shaped to the forms of the mouldings, together with the opening tools before described, are to be worked over every part of the moulding, by which asperities are smoothed down, depressions filled up, and edges brought up nearly to their required sharpness. In this state the whiting on the moulding is from one-sixteenth to one-twelfth of an inch in thickness. It is now trimmed at the back and edges by cutting off the whiting which had flowed over from the front, which prepares it for the process of smoothing. This is done by means of pieces of pumice and other stones, shaped so as to fit the various parts of the moulding. A sponge or soft brush is used to wet the moulding, and the stone which is to be used, being likewise wetted, is rubbed or worked to and fro along the moulding until that part is perfectly smooth. Another stone, fitting a different part, is then used in the same way; and so on, until every part of the length and breadth of the moulding has been worked over by the stones. The moulding, if the smoothing has been properly performed, now presents a smoothness of surface exceeding, and a keenness of the edge nearly equalling, that which the moulding presented when it left the hands of the joiner; but this must be attained without rubbing off too much of the whiting, since the whole beauty of the frame mainly depends on having a sufficient body or foundation of whiting. The brilliant burnishing on frames is, in a peculiar degree, dependent on the whiting which is first laid on the wood, and which, if deficient in quantity, cannot be adequately replaced by other means. The moulding being thoroughly dried from the effects of the smoothing, is rubbed down with glass-paper or sand-paper, to take off any little asperities that may remain, and to make the whole perfectly smooth. It is now ready for the process of gold-sizing. The burnish gold-size used in this process is composed of ingredients exceedingly opposite in their nature, such as pipe-clay, red chalk, black-lead, suet, and bullock's blood. This diversity of ingredients is intended to produce different effects; one substance helps to give a brilliancy to the burnish, another to the mellowness and smoothness, and so on. The form in which the gilder purchases his burnish gold-size is that of a solid rather softer than butter. He first takes some very clear size, boiled purposely to a smaller degree of strength than the size for thick white, or, if already boiled, weakened by water. This size he melts in an earthen pipkin, but without making it very hot, and then mixes the gold size with the melted size by means of a clean brush, much in the same manner as a painter mixes his oil paint; the consistence to be about equal to that of cream. It is a source of some confusion that the same term, burnish gold-size, is applied to this creamy liquid, as to the thicker substance from which it is prepared; it is necessary to say mixed gold-size, or unmixed gold-size, in order to indicate which is meant. This gold size is laid on the moulding either with a very soft hog-hair brush, or by a large camel-hair pencil, fixed in a swan's quill. The gold size must be barely warm, and must be laid on with great care so as to leave it equally thick in every part, and obliterate the marks of the brush; upon the due observance of a medium between hot and cold, strong and weak, and thick and thin, in the gold size laid on, de-

pends much of the beauty of the moulding, when gilt. From 4 to 8 coats of this gold size are laid on the moulding, each one being perfectly dried before the next is applied. A soft, partially-worn piece of glass-paper is occasionally used, to take off any little roughness that may exist. When a sufficient body of gold size is laid on, it is carefully washed with clean water, a soft sponge, and a piece of linen rag. This must be done with attention to the soft edges, which are very likely to lose the whole of their gold size, if care is not used; the object is to produce a perfectly smooth surface, especially in those parts which are to be matt gold. The test of good work is to produce the smoothest surface with the least loss of gold size. When the moulding is partially dry from this process, the matt parts are polished with a piece of woollen cloth, and the parts to be burnished receive another coating of gold size, laid on as smoothly as possible. The piece of moulding which is to be gilt is laid along the bench with one end higher than the other; and as the width of the moulding is broken up into several divisions, such as hollows and squares, it would be impossible to make a leaf of gold bend into all the various parts without breaking. The gilder learns by experience how many separate lays, as they are called, of gold will be required to cover the width of the moulding without the breaking of the gold into irregular fractures called spider-legs. In general, a deep hollow, or a depressed square, cannot be gilt at one lay, but must be covered with two strips of gold laid side by side and meeting at the centre of the depression. When the gilder has made his decision as to the number of lays that will be required, he selects one lay, and proceeds with it through the whole length of the moulding before he begins another portion of the width. If the necessary lay be about $\frac{3}{4}$ or $\frac{7}{8}$ of an inch in width, he cuts the leaf which is spread out on his cushion into four strips; if it be about 1 in. in width, he cuts the leaf into three, regulating the division of the leaf of gold according to the width of the lay. It is not often that a larger piece than half a leaf is used at once. The gilder has at hand a pan with clean water, and two or three camel-hair pencils of different sizes. With one of these pencils he wets a few inches of that part of the moulding which is to form his first lay, taking care not to wet much beyond that lay. The water is to be allowed to remain pretty full on the surface, after some of it has been imbibed by the gold size. The gilder then takes his tip in his right hand, and lays it on the slip of gold, which slightly adheres to the hairs; whence he places it on the moulding, with particular attention to straightness of direction. It frequently happens that the hairs of the tip will not take up the gold; in such case it is usual to rub the hairs between the cheek and the palm of the hand, by which their power of taking up the gold is increased. When the gold is laid on it is blown forcibly, to expel as much of the water as possible from beneath it, the dry camel-hair pencil being used to press down any parts which fail to adhere. Another portion is then wetted, and another piece laid on, lapping about $\frac{1}{8}$ of an inch over the end of the former piece. Thus the gilder proceeds, piece after piece, until the one lay is carried down the whole length of the moulding, he then proceeds with another lay joining the former. In doing this he has to observe that the water must be made to flow a little over the edge of the former lay, but not so as to wash it up, or break away the edge; the second lay must lap a little over the first, and therefore the water must likewise extend over the first lay. Thus he proceeds with all the lays into which he has found it necessary to divide the width of the moulding; every piece, lengthwise, lapping over the piece previously put on, and every lay lapping over the previous lay. The moulding is then set aside to dry. There is a particular state or degree of dryness, known only by experience, in which the moulding is in a fit state for burnishing. The burnishers used by the gilder are either of flint or agate, generally the former; the steel burnishers employed by the

jeweller would not do for the gilder. Burnishers of different forms and sizes must be employed, in order to adapt them to the part of the work which is being burnished; they are generally crooked or curved near the end. When the burnishing is done, those parts which have not been burnished are weak sized, that is, they are wetted with water in which a very little clear piece of size has been melted; this helps to secure the gold. When dry, the gold is wiped carefully with a piece of soft cotton-wool, to remove rough or ragged edges of gold; and there are now visible a number of little breaks, holes, and faulty places in the gilding, arising from the impossibility of laying on the gold quite soundly and perfectly. These defective parts are repaired by the process of faulting, which consists of cutting up a leaf of gold into small pieces and laying them on the faulty places, previously wetted, with a camel-hair pencil. If the defective part is on the burnish, it is necessary to be careful not to wet any part but what is to be covered by the gold, as it will stain the burnished gold. When the faulting is dry, the gold is again carefully wiped, and finally wetted with finishing size. This is clear size of a certain degree of strength, laid on the matt parts with a pencil, and completes the process of gilding. When a glass frame is to be gilt, the joiner's work is generally quite completed before the gilder begins, and great care is required in whiting such frames, to prevent filling up the corners with whiting, and giving them a clumsy appearance. For this purpose, modelling tools, such as chisels, gouges, and crooks, are used to clear out the corners from time to time, and preserve the original sharpness and clearness of the several parts.

Composition for Moulding.—The following is used by gilders;—Mix 14 lbs. of glue, 7 lbs. resin, ½ lb. pitch, 2½ pints linseed oil, 5 pints of water, more or less according to the quantity required. Boil the whole together, well stirring until dissolved, add as much whiting as will render it of a hard consistency, then press it into mould, which has been previously oiled with sweet oil. No more should be mixed than can be used before it becomes sensibly hard, as it will require steaming before it can be used again. Another receipt;—Make a very clear glue with 3 parts of Flanders glue and 1 part of isinglass, by dissolving the two kinds separately in a large quantity of water, and mix them together, after they have been strained through a piece of fine linen to separate the parts which could not be dissolved. The quantity of water cannot be fixed, because all kinds of glue are not homogeneous, so that some require more than others. The proper strength may be found by suffering the glue to become perfectly cold; it must then barely form a jelly. The glue is to be gently heated, then mixed with saw-dust sifted through a fine sieve. The moulds are then to be oiled with nut oil, and the glue pressed into the mould, covered with weighted board, and then set to dry near a stove. When the casting is dry it is to be trimmed.

Burnished Gilt Frames.—When new burnished gilding requires varnishing, white hard spirit-varnish is used, or yellow gold lacquer. Old burnished work must be cleaned with great care. First remove the dust with a badger-hair brush; afterwards clean the gilding by passing a clean sponge dipped in gin and water, lightly over the surface, wiping off the moisture with a very soft dry sponge or silk handkerchief; then apply the varnish, and finish.

Cleaning Gilt Frames.—Gilt frames may be cleaned by simply washing them with a small sponge, wet with urine, hot spirits of wine, or oil of turpentine, not too wet, but sufficiently to take off the dirt and fly marks. They should not be afterwards wiped, but left to dry of themselves.

Re-gilding Frames.—Take a sponge and some clean water and wash the frame well, then let it dry, procure some water gold-size; make some thin size from dry hide or parchment, mix enough warm with the gold size to enable you to work it on the frame with a camel-hair brush, give it two coats; when dry, rub it over with a

piece of fine sand-paper; it will then be ready for gilding. When the frame is covered, rest it on its edge to drain; when perfectly dry dip a pencil into water, and wipe the gold over with it; it will take the particles of gold off and make it appear solid. For any parts not covered, take bits of leaf with a dry pencil, and lay on as before, then give the whole a coat of clear parchment size, brush the back edges over with ochre, and the frame is then ready.

Gilding Pottery.—An air-tight kiln is required, which must be lime-washed every time it is used. On a small scale a retort would do well, made of Stourbridge clay, and fixed in brickwork, with access for drawing trials, bits of pitcher with a little gold on, drawn with tongs. Take ¼ oz. brown gold, ¼ oz. quicksilver, 10 grains tin, 10 grains white-lead, well pound together in Wedgwood mortar and pestle. Then grind on glass slab and muller, with a few drops of water, for several hours; add a drop of water as it dries, then repeat in turpentine, leaving it about the consistency of cream. It is then ready for use, or if kept for a day or two it will work better; it is laid on with a camel-hair pencil. Thin it with turpentine, as it soon dries, and should be kept covered when not in use. A little fat oil is added to make it work better. To make fat oil, evaporate turpentine to the consistency of treacle.

Gilding on Paint.—The paint must first be thoroughly dry. The letters must be written on the paint with gold size, and allowed to get a little dry, or else the writing will appear dull. Now press the gold leaf on the size, and rub it down with a piece of cotton-wool. If by accident there is more than one thickness of gold it will appear dull.

Gilding Zinc.—First coat the zinc with copper by the electrotype process, using an alkaline copper bath, and then gild on the copper, as that takes gold very readily. Organ pipes should be first coated with mastic varnish, and then oil-gilded in the usual manner.

Gold Size.—Yellow ochre, 1 part; copal varnish, 2; linseed oil, 3; turpentine, 4; boiled oil, 5. Mix. The ochre must be reduced to the finest powder, and ground with a little of the oil before mixing.

Fat-oil Gold-Size is made by grinding good stone or Oxford ochre very fine in old fat linseed oil; when ground as stiff as possible, it ought to be kept for several years before it is used; the longer it is kept the better it becomes, as it acquires a rich mellow fatness. When this size is to be applied to work, take as much as is necessary, and mix it up with a little good fat boiled oil to a proper consistence, neither too stiff nor too fluid; then apply the size to the ground, laying it very regularly and rather fully, yet not so as to run or fall into wrinkles. Gilding with oil size is suitable for large picture or looking-glass frames, figured or lettered sign-boards, clock faces, and various articles exposed to the weather, where a great breadth of gilt surface is required, as it possesses more durability and boldness than any other kind of gilding, particularly when the gilding is varnished before it becomes foul. When it is necessary to revarnish old gilding in oil, such work ought always to be well cleaned from dust, grease, or any incrustation which covers the surface, otherwise the varnish will not dry off hard, but will remain cloudy and tacky, so as readily to retain dust and flies. Various methods are employed by painters and gilders to clean old gilt work. Some wash the work well with a brush or sponge, which is sufficient in cases where the ground is firm, hard, and of a metallic colour; but where the grounds are absorbent, with gold letters, simply washing with water is in general insufficient. In such cases, employ an alkaline ley, made by dissolving 2 oz. of pearlash in 3 pints of water; then wet the work over with a brush or sponge dipped in the ley; let it remain some time, afterwards, with the sponge and clean water, wash off a part to see if the surface or gilding is properly clean, when it must be thoroughly washed with plenty of pure water, and wiped dry with a soft cloth or a silk handkerchief. Oil of vitriol and water,

mixed until its acidity is equal to that of vinegar, is very cleansing, but requires considerable practice to apply it equally to the work, and it must not remain on too long, otherwise it will not only remove the dirt, but also the paint and gilding; it requires to be used with caution, frequently applying the sponge and clear water, in order to discover whether the surface is clean. When it is well washed and wiped dry, let the work stand to dry, and afterwards apply one or two coats of copal varnish. In revarnishing old work exposed to the weather, it is best to clean it over-night, and if the weather is fine next morning, and no appearance of rain, high wind, or dust, apply the varnish about sunrise, when the warmth of the sun will cause it to flow, set, and dry quickly and hard.

Flock Gold-Size.—Put 12 galls. of linseed oil into the iron set-pot; as soon as it has boiled 2 hours, gradually introduce 12 lbs. of litharge. Continue the boiling very moderately for 6 hours; let it remain until next morning, then bring it to simmer, and run 10 lbs. of gum animi and 2 galls. of oil. When these two runs of gum are poured into the iron pot, put in 7 lbs. of Burgundy pitch, which soon melt, continue the boiling, and keep ladling it down, as directed for the best gold size, boil it moderately strong, but not over-strong, and when right, mix it with 30 galls. of turpentine, or more if required; this should be left a little thicker and stronger than japanners' gold size, as it is used for paper-stainers to lay their flock on, and ought to dry slowly in 1 hour.

Bronzing Gold-Size is japanners' gold size kept till very bright and tough from age, and then heated up and mixed with 1 gall. of very old carriage varnish to 9 galls. of gold size. This is used for laying on bronze and also gold, by writers, grainers, japanners, and gilders. The greater the proportion of carriage varnish, the slower it will dry. Some paper-stainers like it to dry quicker than others, and writers and grainers like it to dry quicker than gilders and japanners.

Gold Powder for Gilding.—Gold powder may be prepared in three ways; —1st. Put into an earthen mortar some gold leaf, with a little honey, or thick gum-water, and grind the mixture till the gold leaf is reduced to extremely minute particles. When this is done a little warm water will wash out the honey or gum, leaving the gold behind in a powdered state. 2nd. Dissolve the pure gold, or the leaf, in nitro-muriatic acid, and then precipitate it by a piece of copper, or by a solution of sulphate of iron. The precipitate, if by copper, must be digested in distilled vinegar, and then washed, by pouring water over it repeatedly, and dried. This precipitate will be in the form of very fine powder; it works better and is more easily burnished than gold leaf ground with honey as above. 3rd. And the best method of preparing gold powder is by beating a prepared amalgam of gold, in an open clean crucible, and continuing the strong heat, until the whole of the mercury is evaporated; at the same time constantly stirring the amalgam with a glass rod. When the mercury has completely left the gold, the remaining powder is to be ground in a Wedgwood's mortar, with a little water, and afterwards dried. It is then fit for use. Although the last mode of operating has been here given, the operator cannot be too much reminded of the danger attending the sublimation of mercury. In the small way here described, it is impossible to operate without danger; it is therefore better to prepare it according to the former directions than to risk the health by the latter.

To Cover Bars of Copper with Gold, so as to be rolled out into Sheets.—First prepare ingots or pieces of copper or brass, in convenient lengths and sizes. Then cleanse them from impurity, and make their surfaces level. Prepare plates of pure gold, or gold mixed with a portion of alloy, of the same size as the ingots of metal, and of suitable thickness. Having placed a piece of gold upon an ingot intended to be plated, hammer and compress them

both together, so that they may have their surfaces as nearly equal to each other as possible; then bind together with wire, in order to keep them in the same position during the process required to attach them. Afterwards mix silver filings with borax, to assist the fusion of the silver. Lay this mixture upon the edge of the plate, and next to the ingot of metal. Having prepared the two bodies, place them on a fire in a stove or furnace, where they must remain until the silver and borax placed along the edges of the metals melt, and until the adhesion of the gold with the metal is perfect. Remove the ingot carefully from the stove. By this process the ingot is plated with gold, and prepared ready for rolling into sheets.

To Gild in Colours.—The principal colours of gold for gilding are red, green, and yellow. These should be kept in different amalgams. The part which is to remain of the first colour, is to be stopped off with a composition of chalk and glue; the variety required is produced by gilding the unstopped parts with the proper amalgam, according to the usual mode of gilding. Sometimes the amalgam is applied to the surface to be gilt, without any quicking, by spreading it with aquafortis; but this depends on the same principle as a previous quicking.

Grecian Gilding.—Equal parts of salammoniac and corrosive sublimate are dissolved in spirit of nitre, and a solution of gold made with this menstruum. The silver brushed over with it turns black, but on exposure to a red heat it assumes the colour of gold.

To Dissolve Gold in Aqua-Regia.—Take aqua-regia, composed of 2 parts of nitrous acid, and 1 of marine acid; or of 1 part of sal ammoniac, and 4 parts of aquafortis; let the gold be granulated, put into a sufficient quantity of this menstruum, and exposed to a moderate degree of heat. During the solution, an effervescence takes place, and it acquires a beautiful yellow colour which becomes more and more intense, till it has a dark golden or orange colour. When the menstruum is saturated, it is very clear and transparent.

To Gild Iron or Steel with a Solution of Gold.—Make a solution of 8 oz. of nitre and common salt, with 5 oz. of crude alum in a sufficient quantity of water; dissolve 1 oz. of gold thinly plated and cut; and afterwards evaporate to dryness. Digest the residuum in rectified spirit of wine or ether, which will perfectly abstract the gold. The iron is to be brushed over with this solution, and becomes immediately gilt.

To Gild by Gold dissolved in Aqua-Regia.—Fine linen rags are soaked in a saturated solution of gold in aqua-regia, gently dried, and afterwards burnt to tinder. The substance to be gilt must be well polished; a piece of cork is first dipped into a solution of common salt in water, and afterwards into the tinder, which is well rubbed on the surface of the metal to be gilt, and the gold appears in all its metallic lustre.

Amalgam of Gold in the Large Way.—A quantity of quicksilver is put into a crucible or iron ladle, which is lined with clay, and exposed to heat till it begins to smoke. The gold to be mixed should be previously granulated, and heated red hot, when it should be added to the quicksilver, and stirred about with an iron rod till it is perfectly dissolved. If there should be any superfluous mercury, it may be separated by passing it through clean soft leather; and the remaining amalgam will have the consistence of butter, and contain about 3 parts of mercury to 1 of gold.

To Gild by Amalgamation.—The metal to be gilt is previously well cleaned on its surface, by boiling in a weak pickle of very dilute nitrous acid. A quantity of aquafortis is poured into an earthen vessel, and quicksilver put therein; when a sufficient quantity of mercury is dissolved, the articles to be gilt are put into the solution, and stirred about with a brush till they become white. This is called quicking. But as during quicking by this mode a noxious vapour continually arises, which proves very

injurious to the health of the workmen, they have adopted another method, by which they, in a great measure, avoid that danger. They now dissolve the quicksilver in a bottle containing aquafortis, and leave it in the open air during the solution, so that the noxious vapour escapes into the air. Then a little of this solution is poured into a basin, and with a brush dipped therein they stroke over the surface of the metal to be gilt, which immediately becomes quicked. The amalgam is now applied by one of the following methods;—1st. By proportioning it to the number of articles to be gilt, and putting them into a vessel together, working them about with a soft brush, till the amalgam is uniformly spread. Or, 2ndly. By applying a portion of the amalgam upon one part, and spreading it on the surface, if flat, by working it about with a harder brush. The work thus managed is put into a pan, and exposed to a gentle degree of heat; when it becomes hot, it is frequently put into a pan, and worked about with a painter's large brush, to prevent an irregular dissipation of the mercury, till at last the quicksilver is entirely dissipated by the repetition of heat, and the gold is attached to the surface of the metal. This gilt surface is well cleaned by a wire brush, and then artists heighten the colour of the gold by the application of various compositions; this part of the process is called colouring.

To Gild Glass and Porcelain.—No. 1.—Drinking and other glasses are sometimes gilt on their edges. This is done either by an adhesive varnish or by heat. The varnish is prepared by dissolving in boiled linseed oil an equal weight either of copal or amber. This is diluted by a proper quantity of oil of turpentine, so as to be applied as thin as possible to the parts of the glass intended to be gilt. When this is done, which will be in about 24 hours, the glass is to be placed in a stove, till it is so warm as almost to burn the fingers when handled. At this temperature the varnish will become adhesive, and a piece of leaf gold, applied in the usual way, will immediately stick. Sweep off the superfluous portions of the leaf, and when quite cold it may be burnished, taking care to interpose a piece of very thin India paper between the gold and the burnisher. If the varnish is very good, this is the best method of gilding glass, as the gold is thus fixed on more evenly than in any other way. No. 2.—It often happens, when the varnish is but indifferent, that by repeated washing the gold wears off; on this account the practice of burning it in is sometimes had recourse to. For this purpose, some gold powder is ground with borax, and in this state applied to the clean surface of the glass by a camel-hair pencil; when quite dry, the glass is put into a stove heated to about the temperature of an annealing oven; the gum burns off, and the borax, by vitrifying, cements the gold with great firmness to the glass; after which it may be burnished. The gilding upon porcelain is in like manner fixed by heat and the use of borax.

Gilding on Glass.—The glass must be thoroughly cleaned and polished. A size must be prepared as follows;—Isinglass 1 oz., dissolve in just sufficient water to cover it; when dissolved, add a pint of rectified spirit of wine, then increase the quantity to a quart with water; keep tightly corked. Or, take best rum ½ pint, isinglass, ¼ oz. Dissolve the isinglass in the rum at a low temperature, then add ½ pint of distilled water, and filter through a piece of old linen. Place the glass flat on a perfectly level table, then with a clean brush flood the glass with the size to the depth of ⅛ of an inch, raise the gold leaf with a tip and lay it flat on the size; it will almost instantly adhere to the glass; in 5 minutes afterwards place the glass endways at a slight angle against a wall that the surplus size may drain off. Allow the glass to remain in that position for 24 hours, by that time it will be perfectly dry. Draw the pattern or letter on a piece of paper, and with a thick needle pierce holes on the lines at the distance of $\frac{1}{16}$ of an inch apart; place the pounced paper on the gold surface, then dust some powdered whiting well on the paper that it may

penetrate the holes; remove the paper carefully, and there will remain a correct copy of the design on the gold. Now fill up the outlines of the design with oil gold-size in which has been ground some orange chrome, thin it with a little boiled oil and turpentine. When thoroughly dry, wash off the surplus gold with water and a piece of cotton-wool. Back the glass with any suitable colour.

To Gild Leather.—In order to impress gilt figures, letters, and other marks upon leather, as on the covers of books and edgings for doors, the leather must first be dusted over with very finely-powdered dried white of eggs, yellow resin, or mastic gum, upon which lay a leaf of gold. The iron tools or stamps are now arranged on a rack before a clear fire, so as to be well heated, without becoming red hot. If the tools are *letters*, they have an alphabetical arrangement on the rack. Each letter or stamp must be tried as to its heat, by imprinting its mark on the raw side of a piece of waste leather. A little practice will enable one to judge of the heat. The tool is now to be pressed downwards on the gold leaf, which will, of course, be indented, and show the figure imprinted on it. The next letter or stamp is now to be taken and stamped in like manner, and so on with the others; taking care to keep the letters in an even line with each other, like those in a book. By this operation the resin is melted; consequently, the gold adheres to the leather; the superfluous gold may then be rubbed off by a cloth, the gilded impressions remaining on the leather. The cloth alluded to should be slightly greasy, to retain the gold wiped off; the cloth will thus be soon completely loaded with the gold. When this is the case, these cloths are generally sold to the refiners, who burn them and recover the gold.

To Gild, or Finish, Books.—The work, if leather, must be compassed off and marked with a folding stick wherever it is intended to run a straight line. This serves as a guide when the gold is laid on. For good work the pattern must be worked in blind, and, after being washed with a solution of oxalic acid or a thin paste-wash, carefully pencilled in with the glaire-pencil. For morocco bindings, the glaire is sometimes diluted with water. In preparing glaire from the egg for immediate use, a few drops of oxalic acid will be found of service. The gilding is commenced by oiling slightly, with a small piece of cotton, the whole of the work, and arranging the hand-stamps and rolls so as to be conveniently accessible. To lay on the gold, take a book of the metal, open the outside leaf, and pass a knife underneath the gold; with this raise it, carry it steadily on to the cushion, and spread it even, by a light breath on the middle of the leaf. Afterwards the gold must be cut with the gold knife to the breadth and length of the places to be covered, by laying the edge upon it and moving the knife slightly backwards and forwards. Then rub upon the work a little sweet oil, and apply the gold upon the places to be ornamented with a cotton or tip, rubbed on the forehead or hair to give it a slight humidity and cause the gold to adhere. The tools, which must be previously heated, are then applied. Calf will require them hotter than morocco and roan, and these warmer than russia and vellum. To ascertain their proper heat, they are applied on a damp sponge, or rubbed with the finger wetted. The gold which has not been impressed by the gilding tools must be well rubbed off with the gold rag, and cleared with a piece of fine flannel or india-rubber, so as to display the delicate lines of the ornaments as perfectly and clearly as possible. Attention should be paid to this particular; for let a book be finished in the most tasteful manner possible, unless well cleared off the effect is entirely lost. For gilding publishers' work, or where a quantity of gilding is desired at little expense, a stamping-press is brought into requisition, and by means of tools cut for the purpose, called blocks or stamps, the design is impressed on the side. The stamps are fixed to an iron plate, called a back or foundation-plate, upon which a piece of stout

paper has been glued. Let the paper be glued equally over the surface, and proceed to form the pattern by arranging the stamps upon the plate so as to exhibit the design; then take a little paste and touch the under side of each stamp, and place them in exact position. After this is done and the paste has become hard, lay the stamp or pattern thus formed upon the side of the volume, taking care to have the same margin on the front, back, and ends. Then place the board or side upon which the stamp is placed, upon the platen of the stamping press, leaving the volume hanging down in front of the platen, which is then moved to the centre of the upper platen, so that the clamps will touch the plate on both edges at the same moment; then pull the lever so as to put a slight pressure upon the plate in order to keep both it and the side in their proper place; adjust the guides to the fore-edge and head or left-hand side, and screw them fast; throw back the lever, take out the book; examine and correct any irregularity in the margin of the pattern by moving the guides. When perfectly square, place a soft pasteboard under the stamp, pull down the press, and apply heat. This will set the stamps or harden the paste and glue in a short time, so that they will not fall off in stamping. Work for stamping does not require so much body or preparation as work gilt by hand. Morocco can be worked by merely being washed with urine; but it is safer to use a coat of size, or glaire and water mixed in proportions of 1 of the former to 3 of the latter. Grained sheep, or, as it is called, imitation morocco, requires more body to gild well. The books are ready for laying on after an oiled rag has been lightly passed over the surface of the leather, to cause the gold to adhere until it is put under the press. The gold leaf is cut upon the cushion to the required size, or, if the volume is large and the stamps will cover its superficial extent, the leaf may be lifted from the gold book by means of a block covered with wadding or cotton lap, and laid immediately upon the side. Examine the press to see if sufficiently heated for the purpose. A little experience will soon determine the requisite amount of heat. Leather work does not require as hot a tool for stamping as for hand-work, while cloth or muslin-work requires a short, quick stroke, and the press to be hotter than for leather. The stamping press is heated by introducing steam or gas through tubes perforated for the purpose. After the press is properly heated, throw back the lever; take out the pasteboard from under the stamp; regulate the degree of pressure required for the stamp; then place the side to be stamped upon the bed-plate, holding it firmly against the guides with the left hand, while with the right the lever is quickly drawn to the front. This straightens the toggles, and causes a sharp impresssion of the stamp upon the leather; immediately throw back the lever; take out the side, and rub off with a rag the superfluous gold.

To Gild Writings and Drawings on Paper or Parchment.—Letters written on vellum or paper are gilded in three ways. In the first, a little size is mixed with the ink, and the letters are written as usual; when they are dry, a slight degree of stickiness is produced by breathing on them, upon which the gold leaf is immediately applied, and by a little pressure may be made to adhere with sufficient firmness. In the second method, some white-lead or chalk is ground up with strong size, and the letters are made with this by means of a brush; when the mixture is almost dry, the gold leaf may be laid on, and afterwards burnished. The last method is to mix up some gold powder with size, and to form the letters of this by means of a brush.

To Gild the Edges of Paper.—The edges of the leaves of books and letter-paper are gilded whilst in a horizontal position in the bookbinder's press, by first applying a composition formed of four parts of Armenian bole, and one of candied sugar, ground together with water to a proper consistence, and laid on by a brush with the white of an egg. This coating, when nearly dry, is

smoothed by the burnisher. It is then slightly moistened by a sponge dipped in clean water, and squeezed in the hand. The gold leaf is now taken up on a piece of cotton, from the leathern cushion, and applied on the moistened surface. When dry, it is to be burnished by rubbing the agate over it repeatedly from end to end, taking care not to wound the surface by the point of the burnisher. A piece of silk or India paper is usually interposed between the gold and the burnisher. Cotton-wool is generally used by bookbinders to take the leaf up from the cushion; being the best adapted for the purpose on account of its pliability, softness, and slight moistness. 2. Screw the book up as tightly as possible between boards placed even with the edges, scrape he edges perfectly smooth with a steel scraper, burnish with an agate, then colour over with red bole, or chalk ground in soap, rub immediately dry with fine clean paper shavings and burnish again. The size, prepared by well beating up the white of an egg, with three times the quantity of water, must then be applied evenly with a large camel-hair pencil, and the gold laid on with a tip. When dry burnish carefully, to avoid rubbing off the gold. If it is desired that the edges should show red under the gold, first colour the edges with vermilion mixed with glaire, and a little liquor ammoniæ; when dry, moisten with a little gold size, and while the edge is damp lay on the gold.

To Gild Copper by Amalgam.—Immerse a very clean bright piece of copper in a diluted solution of nitrate of mercury. By the affinity of copper for nitric acid, the mercury will be precipitated; now spread the amalgam of gold rather thinly over the coat of mercury just given to the copper. This coat unites with the amalgam, and will of course remain on the copper. Now place the piece operated on in a clear oven or furnace, where there is no smoke. If the heat is a little greater than 66 degrees, the mercury of the amalgam will be volatilized, and the copper will be beautifully gilt.

To Heighten the Colour of Yellow Gold.—Six oz. saltpetre, 2 oz. copperas, 1 oz. white vitriol, and 1 oz. alum. If it be wanted redder, a small portion of blue vitriol must be added. These are to be well mixed, and dissolved in water as the colour is wanted.

To Heighten the Colour of Green Gold.—One oz. 10 dwts. saltpetre; 1 oz. 4 dwts. sal ammoniac; 1 oz. 4 dwts. Roman vitriol; and 18 dwts. verdigris. Mix them well together, and dissolve a portion in water as occasion requires. The work must be dipped in these compositions, applied to a proper heat to burn them off, and then quenched in water or vinegar.

To Heighten the Colour of Red Gold.—To 4 oz. melted yellow wax, add 1½ oz. red ochre in fine powder; 1½ oz. verdigris, calcined till it yields no fumes; and ½ oz. calcined borax. It is necessary to calcine the verdigris, or else, by the heat applied in burning the wax, the vinegar becomes so concentrated as to corrode the surface, and make it appear speckled.

To Separate Gold from Gilt Copper and Silver.—Apply a solution of borax, in water, to the gilt surface, with a fine brush, and sprinkle over it some fine powdered sulphur. Make the piece red hot, and quench it in water. The gold may be easily wiped off with a scratch-brush, and recovered by testing it with lead. Gold is taken from the surface of silver by spreading over it a paste, made of powdered sal ammoniac, with aquafortis, and heating it till the matter smokes, and is nearly dry, when the gold may be separated by rubbing it with a scratch-brush.

Gilding on Steel.—Dissolve any quantity of gold or platina in nitro-muriatic acid, until no effervescence is occasioned by the application of heat. Evaporate the solution of gold or platina thus formed to dryness in a gentle heat; and redissolve the dry mass in as little water as possible; next take an instrument which is used by chemists for dropping liquids, known by the name of a separating funnel, having a pear-shaped body, tapering to a fine point, and a neck capable of being stopped with the finger or a cork; fill it with the liquid

about one quarter part; and the other three parts must be filled with the very best sulphuric ether. If this is rightly managed, the two liquids will not mix. Then place the tube in a horizontal position, and gently turn it round with the finger and thumb. The ether will very soon be impregnated with the platina or gold, which may be known by its change of colour. Replace it in a perpendicular position, and let it rest for 24 hours; having first stopped the upper orifice with a small cork. The liquid will then be divided into two parts; the darkest coloured being underneath. To separate them, take out the cork, and let the dark liquid flow out; when it has disappeared, stop the tube immediately with the cork; and what remains in the tube is the gilding liquid. Let it be put into a bottle, and tightly corked. When an article is to be gilded, a vessel of glass or unglazed ware must be provided, of just sufficient size to admit the article; it must then be filled with the gilding liquid, nearly to the top. The steel must be very highly polished, and entirely free from rust or grease. A basin, full of clean water, must be ready at hand; the article must be immersed into the gilding liquid, and quickly removed; then quickly plunged into the water, and well rinsed; it must next be dried with blotting paper, and be placed in a temperature of 150° Fahr. till it be completely heated throughout; it may then be polished with rouge and a soft leather, or be burnished. Pure gold must be employed. The ethereal solution may also be concentrated by gentle evaporation. Care must be taken not to wipe the steel until the heat has been applied. This gilding is an effectual protection against rust, and is very ornamental.

Gold Leaf for Illumination.—For illumination on a large scale ordinary gilders' size can be used on stout paper. For fine work or water-matt, gold size is useful, but not easy to bring to a smooth surface. Clear gum arabic, used as thickly as is convenient for the paint-brush, makes a good ground for the gold leaf. The ordinary gilding size must be left till it is tacky, that is, all but dry. Having seen that the size is properly tacky, or having breathed on the water size or gum, lay the gold leaf on the work, pressing a piece of slightly-greased paper gently on with the fingers. In a few minutes take up the paper rather briskly from the work, and it should bring away all superfluous gold.

Gold Paper-hangings.—The part which is to show the gilt, is first printed in common size mixed with a little water; when dry, rolled up and reprinted in gold size, and as it is being printed the piece is drawn out from the table into a trough, technically called a drum, and then the metal, which is Chinese bronze, is slightly laid over the surface, and the drum tapped underneath with a common cane, which causes the metal to adhere to the gold size; it is then carefully drawn out of the drum and hung up till dry, then rolled up; to improve the appearance, the hangings are passed between two embossing rollers, which give the finishing touch.

Silvering Looking-glasses.—The metal used is quicksilver. The substance employed to make the mercury or quicksilver adhere to the surface of the glass is tin-foil, as thin as paper, and which has a strong attraction for mercury. A drop of mercury combines with the tin-foil, and they become one substance, which adheres pretty firmly to glass. The glass to be silvered is made perfectly clean on both sides, particularly on that which is to be silvered. If the slightest speck of dirt be allowed to remain on the surface, it will appear very conspicuous when the glass is silvered. The tin-foil is generally made in sheets about 6 ft. long and of various widths, varying from 10 in. up to 40, the diversity of widths being to enable the silverer to cut out small pieces suitable to various-sized glasses. For larger sizes, the foil is generally made to order, and of a greater thickness than for smaller glasses. A sheet of tin-foil being unrolled, is laid down flat, and cut to the same shape as the glass, but an inch larger each way. It is then laid down as smoothly as possible on the silvering stone, which is a

very large and carefully-prepared slab of slate, porphyry, or marble, perfectly flat and smooth. The foil is worked out level and smooth on the silvering stone by means of a smooth wooden roller, which is worked over it in every direction. The silverer pours some mercury into a wooden bowl, and then, by means of an iron ladle, pours the mercury over the whole surface of the foil till every part is covered. The glass plate is then laid upon the liquid mercury; but it is not laid at once flat down on it, being made to slide on the edge of the glass first coming in contact with the mercury. As it is slid along, it pushes before it the greater part of the mercury, because the edge of the glass almost scrapes along the foil as it passes, that all air-bubbles and impurities may be pushed off, allowing only a thin film of very pure mercury to remain between the glass and the foil. In this much care and delicacy are required. It is a matter of some difficulty to clean the glass so perfectly as not to show any marks or streaks after it is silvered. It is often necessary to remove it from the foil two or three times after it has been laid down, to wipe off specks of dirt which are visible when the glass is silvered, however difficult of detection they may previously be; this is especially the case in damp weather. This renders it necessary that the foils for large glass, which necessarily require a longer time than small ones to perform the different processes, should be thicker than those for smaller; for such is the attraction between the mercury and the foil, that if a glass, after having been removed for further cleaning, is not speedily replaced on the mercury, the latter will combine with the foil, and give it a rottenness which will prevent its adhesion to the glass; the thicker the foil, the less this is likely to occur. When the glass is properly placed on the tin-foil, and it is ascertained that all specks and air-bubbles are removed, it is covered almost in every part by heavy iron or leaden weights; so that a large glass will have several hundredweight pressing upon it. This pressure is to force out from between the glass and the foil as much mercury as possible, so that the thinnest film only shall remain between them. To effect this more completely, the silvering stone is made to rest on a swivel underneath, by which it can be made either perfectly horizontal, or thrown into an inclined position. While the glass is being laid on the foil, the silvering stone is horizontal, to prevent the mercury from flowing off; but when the superfluous mercury is to be drained off, the stone is made to assume an inclined position, so as to ensure one general direction for the flow of the mercury. A hollow groove runs round the sides of the stone, into which the mercury flows as it is forced out from between the glass and the foil. A pipe, descending from one corner of this trough, conveys the mercury into a bottle placed beneath to receive it. Although an immense weight of mercury must be poured on the foil for the silvering of a large glass, yet the quantity which actually remains between the glass and the foil is extremely small. The glass, with the weights upon it, is allowed to remain in the inclined position for several hours, or, if the glass is large, it is allowed to remain until the next day, in order that as much as possible of the mercury may be pressed out before the weights are removed. On the removal of the weights, one end of the glass is tilted up and supported by blocks, the other end still remaining on the stone. A piece of foil is then laid on the lowest corner, to draw off the mercury which collects in a little pool at the bottom of the glass. In this state the glass remains from a few hours to 3 or 4 days, according to its size. When as much of the mercury as possible has drained from the glass in this way, the glass is taken up, when it is found that the two metals have combined together, and in the combined state adhere to the glass, which neither the one nor the other would have done separately. The removal of the glass from the stone is effected in different ways, according to its size. If it is not too wide for the arm-

span of the silverer, he takes it by the two edges, lifts it from the stone, and places it edgeways on a shelf or on the floor of the silvering room, resting its upper edge against the wall, and allowing one corner to be lower than the rest, so as to facilitate the draining towards that corner. If the glass is long and narrow, two men take it up instead of one, but in the same manner. If, however, the glass is very large, the following mode is sometimes adopted. The draining room is situated beneath the silvering room, and an opening in the floor of the latter is so arranged that a portion of the silvering table can be let down through it, on account of its facility of motion round the swivel. By a gradual turning of the silvering table, the stone and the glass upon it can be brought into a nearly perpendicular position. In this position of the glass, several men in the lower room grasp it by the edges, and place it against the wall of the room, where it is left to drain. When the plate is thus placed against the wall of the room, it is left to drain for a time, varying from one day to several days, according to its size, in order that any remaining superfluous mercury may leave it, and that the foil may become still better attached to the surface of the glass. When the draining appears to be complete, the glass is ready to be applied to its intended purpose. The above is the process for silvering plate glass. But there is an important reason why common glass, used for cheaper purposes, such as the inferior sort of dressing-glasses, cannot be silvered in this way; for any heavy pressure on such glass breaks it at once, on account of its thinness and crookedness. These common glasses, which are always small in size, are not silvered on a stone, but on a board or flat box. The foil is cut to the requisite size, and laid on the board and covered with mercury, as in the former instance. But instead of sliding the glass on to the mercury, a piece of clean paper is laid on the mercury, and the glass is laid on the paper. The silverer now, laying one hand pretty firmly on the glass, takes hold of the edge of the paper with the other, and by a quick motion, draws out the paper from between the glass and the foil, and with it the greater part of the mercury, together with air-bubbles and impurities,—leaving the glass resting on a thin but brilliant film of mercury; this is a process requiring much manual dexterity. The common glass employed for these purposes is always irregularly bent at its surfaces; it is a general rule to silver the concave side, when one side is more concave than the other. The crown glass now made is better than that which was produced a few years ago, and although it is always curved, yet the curvature is pretty nearly the same in different tables from the same crate. This circumstance assists the silverer, for each silvered glass acts as a weight to another of the same size. It is usual to silver a great number of the same size at the same time; and as each one is silvered, it is placed flat down on a shelf, or in a shallow box; and on it the others are successively laid as they are silvered. The concave side of each is silvered, and as the concavity is nearly equal in all, each one helps to press out the superfluous mercury from the one beneath it. The silvering in common glasses is seldom found to be so perfect as on plate glass, from the impossibility of giving equal pressure in every part.

Silvering Cheap Looking-glasses.—Place a sheet of glass, previously washed clean with water, on a table, and rub the whole surface with a rubber of cotton, wetted with distilled water, and afterwards with a solution of Rochelle salts in distilled water, 1 of salt to 200 of water. Then take a solution, previously prepared by adding nitrate of silver to ammonia of commerce; the silver being gradually added until a brown precipitate commences to be produced; the solution is then filtered. For each square yard of glass take as much of the above solution as contains 20 grammes, about 309 grains, of silver, and to this add as much of a solution of Rochelle salt as contains 14 grammes of salt, and the strength of the latter solution should be so adjusted to that of the silver solution

that the total weight of the mixture above mentioned may be 60 grammes. In a minute or two after the mixture is made it becomes turbid, and it is then immediately to be poured over the surface of the glass, which has previously been placed on a perfectly horizontal table, but the plate is blocked up at one end, to give it an inclination about 1 in 40; the liquid is then poured on in such a manner as to distribute it over the whole surface without allowing it to escape at the edges. When this is effected, the plate is placed in a horizontal position at a temperature of about 68° Fahr. The silver will begin to appear in about 2 minutes, and in about 20 or 30 minutes sufficient silver will be deposited. The mixture is then poured off the plate, and the silver it contains afterwards recovered. The surface is then washed four or five times, and the plate set up to dry. When dry, the plate is varnished, by pouring over it a varnish composed of gum dammar, 20 parts; asphalt or bitumen, 5; gutta-percha, 5; and benzine, 75. This varnish will set hard on the glass, and the plate is then ready for use.

Partially Resilvering Pier Glass.—Remove the silvering from the injured part, clean the glass, form a wall of beeswax round the spot, pour on it some nitrate of silver, and precipitate the silver by sugar, or oil of cloves and spirits of wine. This does not leave a white mark round the prepared place.

Silvering Curved Glass.—This is a French process, used not only for flat surfaces, but also for those which are curved, or cut into patterns. Dissolve 600 grains of neutral nitrate of silver in 1200 grains of distilled water, add 75 drops of a solution composed of 25 parts of distilled water, 10 of sesquicarbonate of ammonia, and 10 of ammonia, sp. gr., 980; add also 30 grains of ammonia, same sp. gr., and 1800 grains of alcohol sp. gr. ·85. When clear, the liquor is decanted or filtered, and mixture of equal parts of alcohol and oil of cassia added to the silver solution in the proportion of 1 of the essence of cassia to 15 of the silver solution; the mixture is agitated and left to settle, then filtered. Before pouring upon the glass surface or into the glass vessel to be silvered, the solution is mixed with 1-78th its bulk of essence of cloves, 1 part oil of cloves, 3 parts alcohol. The glass is thoroughly cleaned, and the silver solution applied and warmed to 100° Fahr. for about 3 hours; the liquid is poured off, and the silver deposit washed, dried, and varnished.

Silvering Glass, Drayton's Process.—A mixture is made of 1 oz. of coarsely pulverized nitrate of silver, $\frac{1}{2}$ oz. spirits of hartshorn, and 2 oz. of water; which, after standing for 24 hours, is filtered, the deposit upon the filter, which is silver, being preserved, and an addition is made thereto of 3 oz. of spirits of wine, at 60° above proof, or naphtha; from 20 to 30 drops of oil of cassia are then added; and, after remaining for about 6 hours longer, the solution is ready for use. The glass to be silvered with this solution must have a clean and polished surface; it is to be placed in a horizontal position, and a wall of putty or other suitable material formed around it, so that the solution may cover the surface of the glass to the depth of from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch. After the solution has been poured on the glass, from 6 to 12 drops of a mixture of oil of cloves and spirits of wine, in the proportion of 1 part, by measure, of oil of cloves to 3 of spirits of wine, are dropped into it at different places; or the diluted oil of cloves may be mixed with the solution before it is poured upon the glass; the more oil of cloves used, the more rapid will be the deposition of the silver; but the operation should occupy about 2 hours. When the required deposit has been obtained, the solution is poured off; and as soon as the silver on the glass is perfectly dry, it is varnished with a composition formed by melting together equal quantities of beeswax and tallow. The solution, after being poured off, is allowed to stand for 3 or 4 days, in a close vessel, as it still contains silver, and may be again employed after filtration, and the addition of a sufficient quantity of fresh ingredients to supply the place of those which have been used. About 18

grains of nitrate of silver are used for each square foot of glass; but the quantity of spirit varies somewhat, as its evaporation depends upon the temperature of the atmosphere, and the duration of the process. By the addition of a small quantity of oil of carraway or thyme, the colour of the silver may be varied. The oil of cassia purchased of different manufacturers varies in quality; therefore on being mixed with the solution it must be filtered previous to use.

Silvering Large Mirrors for Photography.—Dissolve 150 grains of nitrate of silver in 6 oz. of distilled water, and to this add ammonia, drop by drop, until the precipitate at first thrown down is redissolved. Now, having made a solution of caustic potash, in the proportion of $2\frac{1}{4}$ oz. of the potash to 50 oz. of water, add 15 oz. of this to the above solution of silver; and add ammonia as before, until the deep-brown precipitate again thrown down is redissolved. Now add 29 oz. of distilled water, after which allow some solution of nitrate of silver to be dropped in, gently stirring all the while with a glass rod, until a precipitate begins to be formed. Previous to the immersion of the glass to be silvered, dissolve 1 oz. of sugar of milk in 10 oz. of water. This must be filtered and kept in a separate bottle. Have ready a clean glass vessel of a size sufficient to contain the glass plate to be silvered; when everything is ready, mix together the silver solution with that of the sugar of milk, in the proportion of 10 of the former to 1 of the latter. Lower the glass down in the solution until it is a little distance from the bottom, and allow it to remain there for a period of time, varying from 15 minutes to 4 hours, according to the thickness of the coating of silver desired. After removing it from the bath, wash with distilled water, and, when dry, polish by means of a soft pad of cotton-velvet charged with rouge. An intensely brilliant surface may be thus obtained on both sides of the glass plate. Make a 3-grain solution of ammonio-nitrate of silver. Render it slightly turbid by excess of nitrate of silver, and then filter it. Just before using it add to each ounce of the foregoing solution $2\frac{1}{2}$ grains of Rochelle salt, immerse the glass as before, and expose to a subdued light while it remains in the bath. In about 2 hours the deposit of silver will be sufficiently thick.

Silvering Mirrors.—Ten grains of pure nitrate of silver to 1 oz. of distilled water; add carefully, drop by drop, strong ammonia, until the brown precipitate is redissolved. When adding the ammonia keep stirring with a glass rod. In another bottle make a solution of 10 grains of pure crystallized Rochelle salt to 1 oz. of distilled water; then, when you have all ready, pour on sufficient to cover all the glass, using two-thirds of the silver solution, and one-third of the Rochelle salt. The mirror can be prepared well by cleaning it with a little wet rouge, and polished dry with a wash-leather; then warm the glass before the fire, or by letting it lie in the sun, to about 70 or 80°. Pour on the solution as described above, and let it stand in the warm sunshine half an hour or an hour. When silvered, pour on it some clean soft or distilled water, and while still wet wipe it very gently all over with a little soft wadding, wet; this will take off all the roughness, so that it will take but little rubbing with the rouge leather to polish it. When perfectly dry it is easily rubbed up to any exquisite polish.

To Silver Glass Specula.—Prepare three standard solutions. Solution A—Crystals of nitrate of silver, 90 grains; distilled water, 4 oz.; dissolve. Solution B—Potassa, pure by alcohol, 1 oz.; distilled water, 25 oz.; dissolve. Solution C—Milk-sugar, in powder, $\frac{1}{2}$ oz.; distilled water, 5 oz. Solutions A and B will keep in stoppered bottles for any length of time; solution C must be fresh.

The Silvering Fluid.—To prepare sufficient for silvering an 8-in. speculum, pour 2 oz. of solution A into a glass vessel capable of holding 35 oz. Add, drop by drop, stirring all the time with a glass rod, as much liquid ammonia as is just necessary to obtain a clear solution of the grey precipitate first thrown down. Add

4 oz. of solution B. The brown-black precipitate formed must be just redissolved by the addition of more ammonia, as before. Add distilled water, until the bulk reaches 15 oz., and add, drop by drop, some of solution A, until a grey precipitate, which does not redissolve after stirring for three minutes, is obtained; then add 15 oz. more of distilled water. Set this solution aside to settle. Do not filter. When all is ready for immersing the mirror, add to the silvering solution 2 oz. of solution C, and stir gently and thoroughly. Solution C may be filtered.

To Prepare the Speculum.—Procure a circular block of wood, 2 inches thick, and 2 inches less in diameter than the speculum. Into this should be screwed three eye-pins, at equal distances. To these pins fasten stout whipcord, making a secure loop at the top. Melt some pitch in any convenient vessel, and, having placed the wooden block, face upwards, on a level table, pour on it the fluid pitch, and on the pitch place the back of the speculum, having previously moistened it with a little spirits of turpentine, to secure adhesion. Let the whole rest until the pitch is cold.

To Clean the Speculum.—Place the speculum, cemented to the circular block, face upwards, on a level table; pour on it a small quantity of strong nitric acid, and rub it gently all over the surface with a brush made by plugging a glass tube with pure cotton-wool. Having perfectly cleaned the surface and sides, wash well with common water, and finally with distilled water. Place the speculum, face downwards, in a dish containing a little rectified spirits of wine, until the silvering fluid is ready.

Silvering Glass Globes.—1. Take ½ oz. of clean lead, and melt it with an equal weight of pure tin; then immediately add ½ oz. of bismuth, and carefully skim off the dross; remove the alloy from the fire, and before it grows cold add 5 oz. of mercury, and stir the whole well together; then put the fluid amalgam into a clean glass, and it is fit for use. When this amalgam is used for silvering, let it be first strained through a linen rag; then gently pour some ounces thereof into the globe intended to be silvered; the alloy should be poured into the globe by means of a paper or glass funnel reaching almost to the bottom of the globe, to prevent its splashing the sides; the globe should be turned every way very slowly, to fasten the silvering. 2. Make an alloy of 3 oz. of lead, 2 oz. of tin, and 5 oz. of bismuth; put a portion of this alloy into the globe, and expose it to a gentle heat until the compound is melted; it melts at 197° Fahr.; then by turning the globe slowly round an equal coating may be laid on, which, when cold, hardens and firmly adheres. This is one of the cheapest and most durable methods of silvering glass globes internally. 3. Nitrate of silver, 1 oz.; distilled water, 1 pint; strong liquor ammonia, sufficient quantity, added very gradually, to first precipitate and then redissolve the silver; then add honey, ¼ oz. Put sufficient quantity of this solution in the globe, and then place the globe in a saucepan of water; boil it for 10 to 30 minutes, occasionally removing it to see the effect.

Silvering Brass.—1. Take ¼ lb. of cyanide of potassium and ½ oz. of nitrate of silver; dissolve all the cyanide in 16 oz. of distilled or boiled water, and the silver in a similar quantity in another vessel. Into the vessel containing the silver throw a spoonful of common salt; stir this up well with a clean piece of wood and let it settle; dissolve some salt in water, and after the silver solution is settled mix a few drops of the salt water in it. If there is any cloudiness formed it proves that all the silver is not thrown down, and more salt must be added, and then stir and allow to settle. If the addition of salt water has no effect, the water may be decanted off, carefully preserving the white deposit. Now pour some boiling water on this deposit; let it settle, and pour off as before. Do this at least three times; pour off as dry as possible, and add about a pint of clean water, and then, by ½ oz. at a time, the cyanide solution, till all the white precipitate is dissolved; add enough water to make half a gallon. Stir well after each

addition of cyanide solution. If on dipping the article, which must be well cleaned with brick-dust and water, into this solution the silver deposits on immediately and in a dark powder, it must be weakened by adding more water; if it coats slowly, more white precipitate must be prepared, washed, and added to it. This must also be done when the solution is getting short of silver. It works best at about 60 or 70 degrees of heat; a dry, warm room suits the operation. Brass and copper only can be silvered; other metals require a battery. This method gives a beautiful result when the work is polished and burnished. 2. Clean the articles thoroughly, and then immerse them for a few seconds in a solution of cyanide of silver, which will plate them without any further trouble.

SILVERING FOR BAROMETER AND THERMOMETER SCALES.—Take ½ oz. of nitrate of silver; dissolve in half a teacupful of cold water; add ½ lb. of cream of tartar, with 1½ lb. of common salt, beaten or ground fine. Mix and stir well together, adding water until it attains the consistence of a thick paste. Now lay the scale on a board, the brass or copper being previously well cleaned and cast off from fine sand-paper; rub the silvering on with your hand until it attains the appearance of silver, which will be a minute or so; now take the work off the board and rub a little wet whiting over it, wash out in clean cold water, and dry in saw-dust. If varnished with a thin coat of white hard varnish, reduced in spirits of wine, this will last for years. The above quantity of silvering used with care will silver six dozen brewers' thermometers, 14 in. long.

Oxidizing Silver Articles. — Oxidize silver-plated articles by dissolving sulphate of copper, 2 dwts.; nitrate of potash, 1 dwt.; and muriate of ammonia, 2 dwts.; in a little acetic acid. Apply with a camel-hair pencil; but warm the article first, and expose the article to the fumes of sulphur in a closed box; the parts not to be coloured must be coated with wax.

Silvering Powder.—Take 40 grains of silver dust; cream of tartar, 3 drams; common salt, 2; and 40 grains of powder of alum. Polish any silver articles with this powder and a soft leather.

Silvering Powder for Coating Copper.—Nitrate of silver, 30 grains; common salt, 30; cream of tartar, 3½ drams. Mix, moisten with water, and apply.

Silvering by Heat.—Dissolve 1 oz. of silver in nitric acid; add a small quantity of salt; then wash it and add sal ammoniac, or 6 oz. of salt and white vitriol; also ¼ of an ounce of corrosive sublimate; rub them together till they form a paste. Rub the piece which is to be silvered with the paste, heat it till the silver runs, after which dip it in a weak vitriol pickle to clean it.

Mixture for Silvering.—Dissolve 2 oz. of silver with 3 grains of corrosive sublimate; add tartaric acid, 4 lb.; salt, 8 quarts.

Platenizing Silver.—Place some platinum in a small quantity of aqua-regia or nitro-muriatic acid, and keep it in a warm place a few days, it will dissolve. As soon as it has dissolved, evaporate the liquid at a gentle heat until it is as thick as honey, so as to get rid of the excess of the nitric and muriatic acids. Add a little water, and it is ready for use. A dozen drops of this solution goes a long way in platenizing silver. The operation is performed in a small glass or beaker, covered with a watch-glass to keep in the fumes, and placed in a little sand in a saucer, to equalize the heat.

Varnished Silver Leaf.—Use first, prepared ox-gall; next, isinglass; then, alum, to kill the former; finish with hard white lac.

Nitrate of Silver.—1. Add silver to nitric acid, previously diluted with twice its weight of water, in a flask, and apply a gentle heat until the metal is dissolved: the clear liquor is then separated from any black powder which may be present, evaporated, and crystallized. The crystals are dried by exposure to the air, taking care that they do not come in contact with any organic substance. 2. Dissolve the silver in pure nitric acid and evaporate. The nitrate is yielded in square anhydrous tables. Dissolve

this in distilled water, filter, and evaporate again, and the nitrate is obtained pure.

To Separate Silver from Copper.—Mix sulphuric acid, 1 part; nitric acid, 1; water, 1; boil the metal in the mixture till it is dissolved, and throw in a little salt to cause the silver to subside.

Silvering Cast Iron.—Fifteen grammes of nitrate of silver are dissolved in 250 grammes of water, and 30 grammes of cyanide of potassium are added; when the solution is complete, the liquid is poured into 750 grammes of water, in which 15 grammes of common salt have been previously dissolved. The cast iron intended to be silvered by this solution should, after having been well cleaned, be placed for a few minutes in a bath of nitric acid of 1·2 sp. gr., just previous to being placed in the silvering fluid.

To Brighten Tarnished Jewellery.—First wash the articles in this cleansing solution;—Liquor potassæ, 1 fluid oz.; water, 20 fluid oz.; mix. Rinse them in cold or warm water, and then immerse them in the following gilders' pickle;—Common salt, 1 part; alum, 1; saltpetre, 2; water, 3 or 4; mix. Let them remain, stirring them now and then, until the surfaces assume a bright golden appearance. Five minutes at most will suffice, less time is generally required. Wash them again in cold or warm water, and dry them with chamois leather or in hot boxwood saw-dust.

Plating.—1. Nitrate of silver, 1 part; common salt, 1; cream of tartar, 7; powder and mix. 2. Nitrate of silver, 1 part; cyanide of potassium, 3. Both are applied by wetting with a little water and rubbing on the article to be plated, which must be quite clean. Plating done by the above will be very thin, but it will be silver. 3. Get a glazed earthen vessel, put in 1 oz. of nitric acid, place it on a slow fire, it will boil instantly, and then throw in some pieces of real silver; this will be dissolved at once. As soon as dissolved throw in a good handful of common salt to kill the acid, then make into a paste with common whiting. The article required to be silvered to be cleaned from grease and dirt, and the paste to be applied with a little water and wash-leather. This will keep for years.

Frosted Silver.—Dip the article in a solution of nitric acid and water, half and half, for a few minutes, then wash well in clean water and dry in hot saw-dust. When thoroughly dry brush the saw-dust away with a soft brush, and burnish the parts required to be bright.

Silvering Clock Dials.—Rub the dial with a mixture of muriate of silver, tartar, and sea-salt, and afterwards rub off the saline matter with water. This silvering is not durable, but it may be improved by heating the article, and repeating the operation, once, or oftener if thought necessary.

Desilvering.—The following is a liquid which will dissolve silver without attacking copper, brass, or German silver, so as to remove the silver from silvered objects, plated ware, &c. It is a mixture of 1 part of nitric acid with 6 parts sulphuric, heated in a water-bath to 160° Fahr., at which temperature it operates best.

Scouring Articles of Dress.—Among the spots which alter the colour fixed upon stuffs, some are caused by a substance which may be described as simple, and others by a substance which results from the combination of two or more bodies, that may act separately or together upon the stuff, and which may therefore be called compound.

Simple Stains.—Oils and fats are the substances which form the greater part of simple stains. They give a deep shade to the ground of the cloth; they continue to spread for several days; they attract the dust, and retain it so strongly that it is not removable by the brush; and they eventually render the stain lighter coloured upon a dark ground, and of a disagreeable grey tint upon a pale or light ground. The general principle of cleansing all spots consists in applying to them a substance with a stronger affinity for the matter composing them than this has for the cloth, and which shall render them soluble in some liquid menstruum, such as water,

spirits, naphtha, or oil of turpentine. Alkalies are the most powerful solvents of grease; but they act too strongly upon silk and wool, as well as change too powerfully the colours of dyed stuffs, to be safely applicable in removing stains. The best substances for this purpose are; —1. Soap. 2. Chalk, fullers' earth, soap-stone, or French chalk. These should be mixed with a little water into a thin paste, spread upon the stain, and allowed to dry. The spot requires now to be merely brushed. 3. Ox-gall and yolk of egg have the property of dissolving fatty bodies without perceptibly affecting the texture or colours of cloth, and may therefore be employed with advantage. The ox-gall should be purified, to prevent its greenish tint from degrading the brilliancy of dyed stuffs, or the purity of whites. Thus prepared it is the most precious of all substances known for removing these kinds of stains. 4. The volatile oil of turpentine will take out only recent stains; for which purpose it ought to be previously purified by distillation over quicklime. Wax, resin, turpentine, pitch, and all resinous bodies in general, form stains of greater or less adhesion, which may be dissolved out by pure alcohol. The juices of fruits, and the coloured juices of all vegetables in general, deposit upon clothes marks in their peculiar hues. Stains of wine, mulberries, black currants, morellos, liquors, and weld, yield only to soaping with the hand, followed by fumigation with sulphurous acid; but the latter process is inadmissible with certain coloured stuffs. Ironmould or rust stains may be taken out almost instantaneously with a strong solution of oxalic acid. If the stain is recent, cream of tartar will remove it.

Compound Spots.—A mixture of rust of iron and grease is an example of this kind, and requires two distinct operations; first, the removal of the grease, and then of the rust, by the means above indicated. Mud, especially that of cities, is a compound of vegetable remains, and of iron in a state of black oxide. Washing with pure water, followed, if necessary, with soaping, will take away the vegetable juices; and then the iron may be removed with cream of tartar, which itself must, however, be well washed out. Ink stains, when recent, may be taken out by washing, first with pure water, next with soapy water, and lastly with lemon juice; but if old, they must be treated with oxalic acid. Stains occasioned by smoke, or by sauces browned in a frying-pan, may be supposed to consist of a mixture of pitch, black oxide of iron, empyreumatic oil, and some saline matters dissolved in pyroligneous acid. In this case several reagents must be employed to remove the stains. Water and soap perfectly well dissolve the vegetable matters, the salts, the pyroligneous acid, and even the empyreumatic oils in a great measure; the essence of turpentine will remove the rest of the oils and all the pitchy matter; then oxalic acid may be used to discharge the iron. Coffee stains require a washing with water, with a careful soaping, at the temperature of 120° Fahr., followed by sulphuration. The two latter processes may be repeated twice or thrice. Chocolate stains may be removed by the same means, and more easily. Stains which change the colour of the stuff, must be corrected by appropriate chemical reagents or dyes. When black or brown cloth is reddened by an acid, the stain is best counteracted by the application of water of ammonia. If delicate colours are injured by soapy or alkaline matters, the stains must be treated with colourless vinegar of moderate force. An earthy compound for removing grease spots is made as follows:—Take fullers' earth, freed from all gritty matter by settling in water; mix with ½ a pound of the earth so prepared, ½ a pound of soda, as much soap, and 8 yolks of eggs well beaten up with ½ a pound of purified ox-gall. The whole must be carefully triturated upon a porphyry slab; the soda with the soap in the same manner as colours are ground, mixing in gradually the eggs and the ox-gall previously beat together. Incorporate next the soft earth by slow degrees, till a uniform thick paste is formed, which should be made into balls or cakes of a

convenient size, and laid out to dry. A little of this detergent being scraped off with a knife, made into a paste with water, and applied to the stain, will remove it. Purified ox-gall is to be mixed with its own bulk of water, applied to the spots, rubbed well into them with the hands till they disappear, after which the stuff is to be washed with soft water. It is the best substance for removing stains on woollen clothes. The redistilled oil of turpentine may also be rubbed upon dry clothes with a sponge or a tuft of cotton, till the spot disappears; but it must be immediately afterwards covered with some plastic clay reduced to powder. Without this precaution, a cloud would be formed round the stain as large as the part moistened with the turpentine. Oxalic acid may be applied in powder upon the spot previously moistened with water, well rubbed on, and then washed off with pure water. Sulphurous acid is best generated at the moment of using it. If the clothes be much stained, they should be suspended in an ordinary fumigating chamber. For trifling stains, the sulphur may be burned under the wide end of a small card or paper funnel, whose upper orifice is applied near the cloth.

Manipulations.—These consist, first, in washing the clothes in clean soft water, or in soap-water. The cloth must next be stretched on a sloping board, and rubbed with the appropriate reagent as above described, either by a sponge or a small hard brush. The application of a red-hot iron a little way above a moistened spot often volatilizes the greasy matter out of it. Stains of pitch, varnish, or oil paint, which have become dry, must first be softened with a little fresh butter or lard, and then treated with the powder of the scouring ball. When the gloss has been taken from silk, it may be restored by applying the filtered mucilage of gum tragacanth; stretching it upon a frame to dry. Ribbons are glossed with isinglass. Lemon juice is used to brighten scarlet spots after they have been cleaned.

Scouring Shawls.—Scrape 1 lb. of soap, and boil it down in sufficient water to make it a thin jelly. When cold, beat it with the hand, and add three tablespoonfuls of spirits of turpentine and one of spirits of hartshorn. Wash the shawl thoroughly in this mixture, then rinse in cold water until all the soap is taken off. Next rinse it in salt and water, in order to prevent the colours striking. Wring the water out, fold between two sheets, taking care not to allow two folds of the article washed to lie together; mangle, and iron with a cool iron.

To Scour Point Lace.—Fix the lace in a prepared tent, draw it tight and straight, make a warm lather of Castile soap, and with a fine brush dipped in, rub over the lace gently, and when clean on one side, do the same to the other, then throw some clean water on it, in which a little alum has been dissolved, to take off the suds; and having some thin starch, go over with it on the wrong side, and iron it on the same side when dry, then open with a bodkin, and set it in order. To clean the same, if not very dirty, without washing, fix it as before and go over with fine bread, the crust being pared off, and when done dust out the crumbs.

To Scour Lace of all kinds.—Get anything round, of convenient size, say a wine bottle, as that will not stain. Wind round smoothly and carefully with a piece of soft material; gently sponge the dirt away in tepid soapy water, no soda to be used; and when clean, and before dry, pass through weak gum water. Pick out, and lay in the sun to dry. If it is wished to bleach it, rinse it in some weak chloride of lime water, and expose it to the air. It must be very weak, or it will seriously damage the lace. Starch it and expose it; then boil and starch, and expose again if not white enough.

Reviving Sable and other Furs.—Thoroughly sprinkle every part with hot flour and sand, and well brush with a hard brush. Then beat with a cane, comb it smooth with a wet comb, and press carefully with a warm iron. For ermine use plaster of Paris instead of

flour and sand, and treat in the same way.

Tanning.—The skin of an animal must be carefully cleansed of hair, fat, and dirt, washed with lime water, and then with water containing a small quantity of oil of vitriol; it is then immersed in an infusion of oak bark, or other astringent vegetable matter containing tannic acid. The process is a slow one; thick hides require 12 to 18 months' preparation for the market; whilst thin leather, to be dressed for such purposes as the uppers of boots, take 3 or 4 weeks.

Tanning by the Decoction of Bark.—Fill a boiler of copper, or any other metal that does not stain or colour the liquor, half full with ground oak bark, and pour water upon it, up to the brim. The whole is then to be boiled for 3 hours, till the tanning principle is completely extracted. The liquor is then to run off by a cock into pits, where it stands to cool. The hides are put into the liquor, and handled frequently, by taking them out and putting them in again, because the liquor is too powerful for them to remain long at a time in the first stages of tanning. They are then to be removed to fresh liquors from time to time as the old is weakened, until the operation is complete. If leather is required with a lighter colour or bloom, a small quantity of the dust of bark is mixed with the liquor. Besides bark, oak chips and oak saw-dust may be used; and the barks of most trees that produce hard wood have a tanning principle in them. The young shoots from the roots of oaks, and the superfluous twigs or branches, may be lopped off, so as not to injure the trees. These, when cut in proper season, may be chopped and ground, and boiled with bark, and will produce a strong tanning liquor. The trunk, roots, limbs, branches, and leaves of the oak, whether tree, pollard, coppice, or underwood, possess tanning properties in a sufficient quantity to be employed with advantage for tanning, by reducing them to chips or saw-dust, and then boiling and using them in the following way;—

To Tan Calf or other Thin Skins, put cwt. of the limbs or branches, chopped as above mentioned, into a copper containing about 60 galls. of water, and boil till the water be reduced to from 35 to 40 galls.; draw off the decoction. Now add to the same limbs or branches 40 galls. of water, and again boil till the water be reduced to about 25 galls. The liquor thus produced by the second boiling is used as a weak ooze, in the first process of immersing the calf-skins after they come from the scouring beam. The decoction first produced is next to be used in the same way.

To Tan Hides, take 1 cwt. of the limbs or branches, and $\frac{3}{4}$ of a cwt. of oak saw-dust—the sooner the latter is used after being made the better—and $\frac{1}{4}$ of a cwt. of the root; boil in 80 galls. of water, till reduced to from 50 to 60 galls. Draw off the decoction, and put it aside for use. To the materials left in the copper add 60 galls. of water, and again boil till reduced to from 30 to 35 galls. The liquor produced by this second boiling is to be employed in the first stage of tanning hides after they come from the beam; and afterwards the decoction first produced is to be employed. The skins and hides having undergone the before-mentioned processes, add as much oak bark or tan liquor, or both, to the respective decoctions as is necessary to complete the tanning. The quantity of each will vary according to the strength of such decoctions; which strength will depend on the age and size of the tree, and other circumstances.

Sheep-skins. — Sheep-skins used for purposes such as gloves and book-covers, and which, when dyed, are converted into mock-morocco leather, are dressed as follows;—They are first to be soaked in water and handled, to separate all impurities, which may be scraped off by a blunt knife on a beam. They are then to be hung up in a close warm room to putrefy. This putrefaction loosens the wool, and causes the exudation of an oily and slimy matter, all which are to be removed by the knife. The skins are now to be steeped in milk of lime, to harden and thicken; here they remain for a month or six weeks, according to circumstances, and, when taken out,

they are to be smoothed on the fleshy side by a sharp knife. They are now to be steeped in a bath of bran and water, where they undergo a partial fermentation, and become thinner in their substance. The skins, now called pelts, are to be immersed in a solution of alum and common salt in water, in the proportion of 120 skins to 3 lbs. of alum and 5 lbs. of salt. They are to be much agitated in this compound saline bath, in order to become firm and tough. From this bath they are to be removed to another, composed of bran and water, where they remain until they become quite pliant, by a slight fermentation. To give their upper surfaces a gloss, they are to be trodden in a wooden tub, with a solution of yolks of eggs in water, previously well beaten up. When this solution becomes transparent, it is a proof that the skins have absorbed the glazing matter. The pelt may now be said to be converted into leather, which is to be drained from moisture, hung upon hooks in a warm apartment to dry, and smoothed over with warm hand-irons. To prepare sheep leather for various elegant purposes, by drying; the skins, after being taken from the lime bath, are to be immersed in another, composed of dog and pigeon dung dissolved by agitation in water; here they remain until the lime is separated, and until the skins have attained the state of soft pliable pelt. To dye this pelt red, the skins are to be washed and sewed into bags, and stuffed with clippings and shavings of leather, or any other convenient substance, and immersed with the grain side outwards in a bath of alum and cochineal of the temperature of 170° or 180° Fahr., where they are to be agitated until they are sufficiently dyed. Each bag is now to be transferred to a sumach bath, where they receive consistency and tenacity. From this bath it is customary to remove the skins, and to plunge them into a saffron one, to improve their colour. To dye these skins black, the washed pelt is first immersed in the sumach bath, and then to be rubbed over on the grained side by a stiff brush dipped in a solution of acetate, or pyrolignite of iron. To give these skins the grain and polish of morocco leather, they are first oiled and then rubbed on a firm board by a convex piece of solid glass, to which a handle is attached. The leather being now rendered more compact, is rubbed or pressed hard by a sharply-grooved boxwood instrument, shaped like the glass one just described. Lamb and kid skins are dressed, tanned, and dyed in a similar manner.

Morocco Leather.—Goat or sheep skins are to be cleansed, have their hair removed, and to be limed as in the before-mentioned processes. They are then to undergo a partial fermentation by a bath of bran and water, and afterwards to be immersed in another bath of white figs and water, where they are to remain for five or six days. It is now necessary to dip them in a solution of salt and water, to fit them for dyeing. To communicate a red colour, the alum and cochineal bath is to be used for sheep-skins; for black, sumach and iron liquor, as before; and for yellow, the bath is to be composed of alum and the pomegranate bark. The tanning, dressing, and graining are the same as for sheep-skins.

Russia Leather.—Calf-skins being steeped in a weak bath of carbonate of potass and water, are well cleaned and scraped, to have the hair and dirt removed. They are now immersed in another bath, containing dog and pigeon's dung in water. Being thus freed from the alkali, they are thrown into a mixture of oatmeal and water, to undergo a slight fermentation. To tan these hides it is necessary to use birch bark instead of oak bark; and during the operation they are to be frequently handled or agitated. When tanned and perfectly dry, they are made pliable by oil and much friction; they are then rubbed over gently with birch tar, which gives them that agreeable odour peculiar to this kind of leather, and which secures them against the attacks of moths and worms. This odour the leather will preserve for many years; and on account of it Russia leather is much used in binding books. The marks or intersecting lines on this leather are given to it by passing over its grained surface a heavy iron

cylinder, bound round by wires. To dye this leather of a black colour, it is to be rubbed over, after tanning, with a solution of acetate, or pyrolignite of iron; to dye it red, alum and Brazil wood are used.

Another Russia Leather.—Deer and goat skins are cleaned and dressed in the same manner as sheep-skins, and then put into a bath of bran in a state of fermentation with water, for three days. Each skin is then put into a wooden tray, where, being spread out, it receives a portion of a liquor composed of honey and water. When the skin has combined with this liquid, it is immersed in very salt brine for a short time, and is then dried. To dye it red, it is to be made up in bags, and dipped in a bath of cochineal water and alkali; it is now to be immersed in a solution of alum, and then tanned with sumach. To give this leather a brilliant and more lasting red, it is dipped in an infusion or decoction of galls, instead of sumach. When to be dyed yellow, the berries of buckthorn or the flowers of wild camomile are used. The graining of this leather is given by an iron instrument of great weight, having a number of blunt points.

Tanning Nets.—Put 1 cwt. of oak branches, and 1 cwt. of spent bark, from any tannery, into 100 galls. of water, and so in proportion for a greater or less quantity. After boiling the same till reduced to about 80 galls., take the branches and spent bark from the copper, and then immerse as many nets, sails, or other articles, as are required, into the liquor left in the copper, taking care that they are completely covered. Boil the whole together for about three hours, then remove the fire, and allow the liquor to get cool; after which remove the nets, sails, or other articles from the furnace, and hang them to dry.

Tanning Sheep or other Skins with the Wool on.—All fragments of flesh must be scrupulously removed with a knife, taking care not to cut or bruise the inner skin; then dry with towels, and lay the skin on a flat board or slab. With hot water, soft-soap, and a hard brush, thoroughly scrub the inside of the skin. Crush and mix together 2 oz. of salts of tartar and 1 oz. of ammonia, which sprinkle on the skin while you scrub it. This will free it from grease. After well scrubbing the skin, rub it well with dry saw-dust, and in a few hours it will be ready for the tanning pickle. This preparation consists of 1 lb. of fine oatmeal, 8 oz. of corrosive sublimate, 4 oz. of saltpetre, and 1 gall. of vinegar. Boil the vinegar, and pour it over the solid ingredients, stirring the whole briskly while in the act of pouring. Let the solution get quite cold, and then immerse the skin, which may be allowed to remain and soak for at least two days. Then take it out, and strain it tightly over a stretcher till it is quite dry. During the process of drying, comb and smooth the wool or hair. In the course of a week the skin will be ready for use.

Preserving Small Skins.—They are first cleaned and scraped; they are then rubbed over with arsenical soap, prepared thus;—To 4 lbs. of white curd soap add 1 lb. of arsenic and 1 oz. of camphor; cut the soap into thin slices, and dissolve it in 1 pint of water. When melted, add the arsenic and camphor, stirring them well together, and boil again until a thick paste is attained, and pour it into jars while hot. When cold, tie it up carefully with bladder, and it will retain its qualities for years.

Discolouration of Leather.—In the process of tanning, leather is made to take up tannic and gallic acids; these combine with iron, derived from the metallic surfaces of the press, and form tannate and gallate of iron, both of them black, hence the stained leather. This discolouration may be prevented by not allowing the iron surfaces to come in contact with the wet leather. Brass moulds would not be open to the same objection.

Tanning Sole Leather.—Wash the hide in running water to cleanse from blood and dirt. Then immerse in milk of lime for about a week, removing the hide gradually from a weak to a strong solution. The lime kills the grease, and loosens the hair and epidermis. Place the hide on a convex beam, and scrape off the hair with

a blunt two-handled concave knife. Next remove all flesh that may be left on the hide in flaying, by cutting off with a sharp two-handled convex knife. Wash the hide in clean water, and it is ready for tanning. The bellies and head are mostly trimmed off, and tanned for in-sole, the butt only being fit for sole leather. The tanning liquor is made by pumping water upon ground bark, in large piles and letting it stand until it has dissolved the tannic acid out of these materials. The hide is then immersed in this liquor, and gradually removed to pits containing stronger and stronger liquors, until the tannic acid has penetrated through it. It is then removed to other pits called layers, where the hides are placed flat on each other, with layers of ground bark between, and the pit filled up with strong liquor. After they have been there some months the process of tanning is finished. It is then struck or smoothed on the grain side with a blunt three-cornered knife, rolled with a heavy roller, and dried.

Preparing Skins.—Any skin can be made white and the coat preserved by taking a blunt knife and scraping the skin on a piece of circular wood, so as to get off as much of the flesh and fat as possible; then make a solution of alum, salt, and water, 4 salt to 1 of alum, as much as the water will contain. Dissolve the alum in hot water, when cold immerse the skin in it, and in about 48 hours the skins will be cured. Wash in a weak solution of soda and water, to carry off any fat that may remain. If for sheep, or other skins that are thicker, a longer time will be required.

Dyeing Leather.—*Blue.*—1. Steep the leather for a day in urine and indigo, then boil it with alum; or it may be given by tempering the indigo with red wine, and washing the skins therewith. 2. Boil elder-berries, or dwarf elder, then smear and wash the skins therewith, and wring them out; then boil the berries as before in a solution of alum water, and wet the skins in the same manner, once or twice; dry them, and they will be very blue.

Red.—Wash the skins, and lay them 2 hours in galls; then wring them out, and dip them in a liquor made with privet-berries, alum, and verdigris in water; and lastly in a dye made of Brazil wood boiled with ley.

Purple.—Wet the skins with a solution of roche alum in warm water, and when dry again rub them, with the hand, with a decoction of logwood in cold water.

Green.—Smear the skin with sap-green and alum water boiled.

Dark Green.—Steel filings and sal ammoniac, steeped in urine till soft, then smeared over the skin, which is to be dried in the shade.

Yellow.—Smear the skin over with aloes and linseed oil, dissolved and strained, or infuse it in weld.

Light Orange.—Smear with fustic-berries, boiled in alum water; or, for a deep orange, with turmeric.

Sky-colour.—Indigo steeped in boiling water, and the next morning warmed and smeared over the skin.

Chamois Leather.—Generally made from sheep or doe skin. After dressing and liming, oil well on the grain side, beat for several hours in a fulling mill, air, oil, and full twice again, or oftener if necessary. Ferment or heat in a warm room, and scour in a weak alkaline ley to remove superfluous oil. Rinse in clean water, wring, and finish with a stretcher iron.

Tawed Leather.—Soak and scrape the skins, and hang in a warm room until the odour of ammonia is given off, when the air or wool may be readily removed. Soak for several weeks in water and quicklime, which must be changed several times during that period. Beam, smooth, and trim the skins again, wash and soak in a vat containing bran and water, where they must gently ferment for some weeks. Remove, and place in a warm solution of alum and salt, in which they must be well worked about. Again ferment in bran and water, then remove, drain, stretch on hooks, and hang to dry in a warmed room. Place in water to soak again, and then thoroughly work about in a mixture of the yolks of eggs beaten to a froth in

water; stretch and hang to dry, smooth with a warm iron. To shorten this process, after the first soaking in bran and water, the skins may be soaked in part of the following mixture largely diluted with water;—Dissolve 8 lbs. alum, and 3½ lbs. common salt, in sufficient boiling water, add 21 lbs. wheat flour, and yolks of 100 eggs, make the whole into a paste.

Tannic Acid.—Make an infusion of galls, precipitate with a concentrated solution of carbonate of potassa, avoid adding an excess of this solution. Wash the precipitate in very cold water, dissolve it with dilute acetic acid, filter the solution, precipitate with acetate of lead, wash the precipitate with water; suspend it in water, and decompose by a stream of sulphuretted hydrogen; evaporate the filtered liquid in vacuo, or over sulphuric acid.

Dressing Furs and Skins.—If the skin has been already dried, soak it in clean, and if possible running, water for 24 hours, working it with the hands repeatedly during that time, until it becomes quite soft. Remove any small pieces of flesh or fat which may have adhered to the skin, and in the case of full-sized tiger-skins, which are very thick and stiff behind the neck, pare or scrape them down until reasonably thin, but with smaller skins this is unnecessary. If the skin is fresh, and has not been dried, it need only be washed to remove any dust or dirt. Skins which have been tanned without being previously dried always turn out the softest. Now prepare the following mixture, the quantities given are sufficient for a small tiger-skin, and must be proportionately increased or diminished for different sized skins;—Alum, very finely powdered, 5 lbs.; salt, well powdered, 2 lbs.; coarse wheat meal, 2 lbs. Mix the above in a large stoneware basin or wooden bucket, and add gradually sufficient sour milk or sour buttermilk to bring it to the consistency of cream. Having previously allowed the soaked skin to drain until most of the moisture has evaporated, lay it on a firm table, with the hair underneath, and taking some of the above mixture, rub it thoroughly into every part of the flesh side of the skin, using as much force with the hands as possible, so as to drive the mixture into the pores of the skin. Much of the success of the operation depends upon giving the skin as much rubbing and handling as possible. When it will absorb no more, cover it with a layer of the composition about ⅛th of an inch thick, fold it up with the flesh surfaces together, and the hair outside, and lay it aside in a cool place. The mixture is only to be put on the flesh side, not on the hair. Next day open out the skin, add more of the mixture, rub thoroughly, and fold up as before. Repeat daily for two days more. Now wash the skin thoroughly in clean water, removing all the composition, hang up to drain, and when half dry rub in a fresh supply of the mixture, and repeat the rubbing daily, adding more of the composition when necessary. In 5 days from the first washing wash again, apply fresh mixture, and rub once daily for 7 or 8 days more, making in all about 17 days. This should be ample for a full-sized tiger-skin, if the rubbing has been well performed, and, indeed, the greater part of the skin would be found to be tanned by the 12th or 14th day, but the skin of the neck and head, even when it has been pared down, is still very hard and tough, and is but slowly acted upon by the tanning mixture. For smaller skins 8 or 10 days will be found sufficient, according to the amount of rubbing. When tanned sufficiently, wash thoroughly in clean water repeatedly changed, or, what is preferable, in a running stream. This washing must be thoroughly done, because if any of the salt of the mixture is left in the skin it will absorb the damp on every gloomy day. Now take a strong solution of plain alum without salt, and after the skin has drained lay it out on a flat surface, exposed to the sun if possible. Apply the alum solution to the flesh side, and let it dry. The skin will now be found as hard as a board. Roll it up into a tight roll, fur outside; take a

mallet and beat it thoroughly until it is less stiff. Open it out, and stretch it as follows;—Get any blunt instrument with a rounded edge, a large shoemaker's rasp does excellently, and, laying the skin on the floor, proceed to work it from the centre to the sides with the blunt end of the tool, steadying the skin by placing the foot on it, using the tool with the right hand, and holding the skin with the left. When thoroughly worked all over, smooth with pumice-stone, and it is finished. The more the skin is worked the softer it will be.

PRESERVATION OF LEATHER.—The extreme heat to which most people expose boots and shoes during winter deprives leather of its vitality, rendering it liable to break and crack. Patent leather particularly is often destroyed in this manner. When leather becomes so warm as to give off the smell of leather, it is singed. Next to the singeing caused by fire heat, is the heat and dampness caused by the covering of rubber. Close rubber shoes destroy the life of leather. The practice of washing harness in warm water and with soap is very damaging. If a coat of oil is put on immediately after washing, the damage is repaired. No harness is ever so soiled that a damp sponge will not remove the dirt; even when the sponge is applied, it is useful to add a slight coat of oil by the use of another sponge. All varnishes and all blacking containing the properties of varnish should be avoided. When harness loses its lustre and turns brown, which almost any leather will do after long exposure to the air, the harness should be given a new coat of grain black. Before using this grain black, the grain surface should be thoroughly washed with potash water until all the grease is killed, and after the application of the grain black, oil and tallow should be applied to the surface. This will not only fasten the colour, but make the leather flexible. Harness which is grained can be cleaned with kerosene or spirits of turpentine, and no harm will result if the parts affected are washed and oiled immediately afterward. Vitriol blacking for boots is generally used until every particle of the oil in the leather is destroyed. To remedy this, the leather should be washed once a month with warm water, and when about half dry, a coat of oil and tallow, or, best of all, castor oil, should be applied, and the boots set aside for a day or two. This will renew the elasticity and life in the leather, and when thus used upper leather will seldom crack or break. When oil is applied to belting dry, it does not spread uniformly, and does not incorporate itself with the fibre, as when partly damped with water. The best way to oil a belt is to take it from the pulleys, and immerse it in a warm solution of tallow and oil. After allowing it to remain a few moments, the belt should be immersed in water heated to 100°, and instantly removed. This will drive the oil and tallow all in, and at the same time properly temper the leather.

Harness Polish.—4 oz. glue, $1\frac{1}{2}$ pint vinegar, 2 oz. gum arabic, $\frac{1}{2}$ pint black ink, 2 drams isinglass. Break the glue in pieces, put it in a basin, and pour over it about a pint of the vinegar; let it stand until it becomes soft. Put the gum in another vessel, with the ink, till it is perfectly dissolved; melt the isinglass in as much water as will cover it, which may be easily done by placing the cup containing it near the fire about an hour before you want to use it. To mix them, pour the remaining vinegar with the softened glue into a saucepan upon a gentle fire, stirring it till it is perfectly dissolved, that it may not burn to the bottom, being careful not to let it reach the boiling point—about 180° Fahr. is the best heat. Next add the gum, let it arrive at about the same heat again; add the isinglass. Take from the fire, and pour it off for use. To use it, put as much as is required in a saucer; heat it sufficiently to make it fluid, and apply a thin coat with a piece of dry sponge; if the article is dried quickly, either in the sun or by the fire, it will have the better polish. This answers equally well for boots or shoes.

Waterproof Harness Paste.—Put into a glazed pipkin 2 oz. of black resin;

place it on a gentle fire. When melted, add 3 oz. of beeswax; when this is melted take it from the fire—add ½ oz. of fine lamp black, and ½ a dram of Prussian blue in fine powder. Stir them so as to be perfectly mixed, then add sufficient spirits of turpentine to form a thin paste; let it cool. To use it, apply a coat, with a piece of linen rag, pretty evenly all over the harness; then take a soft polishing brush, and just brush it over, so as to obtain a bright surface.

Boot-top Liquid.—1. Dissolve in a quart of water 1 oz. of oxalic acid, and the same of white vitriol, with which sponge the leather, previously washed with water, then wash off the composition with water, and dry. This is for white tops. For brown mix 1 oz. of oxalic acid, 1 oz. of spirits of salts, a scruple of cochineal bruised, and a pint of boiling water, and use as before. These mixtures should be labelled poison. Also, for brown tops, mix with a pint of skimmed milk, ½ oz. of spirits of salts, ½ oz. spirits of red lavender, 1 oz. of gum arabic dissolved in water, and the juice of two lemons. Keep the mixture closely corked, sponge the tops when dry, and polish with a brush. 2. White—Alum, cream of tartar, magnesia, and oxalic acid, of each 1 oz.; salt of sorrel and sugar of lead, of each ¼ oz.; water, 1 quart. Mix. Brown—Alum, annato, and oxalic acid, of each 1 oz.; isinglass and sugar of lead, of each ½ oz.; salt of sorrel, ¼ oz.; water, 1 quart. Boil for 10 minutes.

Driving Belts.—Fat should be applied to belts once every three months. They should be first washed with lukewarm water, and then have leather-grease well rubbed in. A good leather-grease may be made from fish-oil, 4 parts; lard or tallow, 1; colophonium, 1; wood-tar, 1.

Varnish for Boots and Shoes.—1. Take a pint of linseed oil, with ½ lb. of mutton suet, the same quantity of beeswax, and a small piece of resin. Boil all this in a pipkin together, and use it when milk-warm with a hair brush; two applications will make the articles waterproof. 2. Common tar made warm, and brushed over the soles of boots or shoes; these are to be put near the fire, that the tar may be absorbed. When this is the case, a second, and afterwards a third may be used with advantage. This is not applicable to the upper leathers, though it makes the soles very much more durable, and impervious to moisture. 3. India-rubber varnish is a valuable article to anoint the upper leather of boots and shoes. It covers them with a resisting varnish; but the lower parts subject to wear from contact with the ground are little benefited by its application.

Cleaning Harness, or Saddles and Bridles.—If harness, wash it perfectly clean with warm water and soft-soap, and when dry, apply neat's-foot oil and black dye, mixed; mix them by adding a small quantity of salts of wormwood, when they will be well blacked and pliable. Then apply on the top of the straps Wrigley's composition. At the same time, by applying the oil and dye to the bottom or under parts of the straps, and composition to the top, they will always be pliable, and have a good polish on the top. If a riding saddle, wash in cold water and soft-soap until free from dirt; then apply soft-soap with a woollen cloth—about two table-spoonfuls would be enough for a saddle—which will dry in. If the saddle is to have a yellow appearance, infuse a penny-worth of hay saffron in about four or five table-spoonfuls of water, and apply before the soft-soap; then rub on to a piece of woollen cloth, or a brush, a piece of beeswax, and finish the saddle off with it, rubbing till a good polish is obtained.

Blacking for Harness.—1. Treacle, ½ lb., lampblack, 1 oz.; yeast, a spoonful; sugar-candy, olive oil, gum tragacanth, and isinglass, each 1 oz.; and a cow's gall. Mix with two pints of stale beer, and let it stand before the fire for an hour. 2. Treacle, 8 parts; lampblack, 1; sweet oil, 1; gum arabic, 1; isinglass, 1; water, 32. Apply heat to the whole; when cold, add 1 oz. spirits of wine, and apply with sponge. If it should get hard, place the bottle in warm water a short time.

Harness Composition.—Put into a glazed pipkin 2 oz. of black resin; place

it on a gentle fire; when melted, add 3 oz. of beeswax. When this is melted, take it from the fire, add ½ oz. of fine lampblack, and ½ dr. of Prussian blue in fine powder; stir them so as to be perfectly mixed, and add sufficient spirits of turpentine to form a thin paste; let it cool. To use it, apply a coat with a piece of linen rag pretty evenly all over the harness; then take a soft polishing brush and brush it over, so as to obtain a bright surface.

To Preserve Leather Driving-bands and Leather Water-hose.—Old leather can be partially renovated by being impregnated with castor oil, and new leather can be preserved by the same means for a very much longer time than by any process heretofore in use. Old boots can be rendered soft and pliable by its application, and, unlike other oily applications, castor oil does not prevent the polish from blackening. Leather hose and driving belts for machinery treated with castor oil have been found to last years longer than ordinarily. Belts impregnated with castor oil will not slip, and a belt 3 inches wide, treated with castor oil, will perform the part of a belt 4½ inches wide on which the oil has not been used, and where the latter would last only from 3 to 5 years the former would last 10. Old fire-hose may be treated with castor oil, and rendered as soft as new. An additional recommendation to castor oil as a preservative of leather is that rats dislike it exceedingly.

Piecing Leather Straps without Laces.—Dissolve best gutta-percha in bisulphide of carbon till it attains the consistency of thick glue; it will give a cement that will do excellently for straps, provided they are not subjected to such friction as will make them warm. The piecing must be nicely spliced, and made so thin at the ends that it will not catch in working; then spread as much of the cement on as will cover; allow it to stand 2 or 3 minutes, then warm the splicing over a fire, lay them together, and hammer or otherwise press them well. In a few minutes the piecing will be so firm as to withstand the efforts of two or three men to pull it asunder.

Softening Leather.—Mix 1 pint of boiled linseed oil, 2 oz. of beeswax, 1 oz. of Burgundy pitch, 2 oz. of turpentine, and melt them together over a slow fire. The mixture should be well rubbed into the leather on both sides, but principally on the flesh side.

Fastening Emery to Leather.—Boil glue very thin, add a little milk, raise the pile of the leather, and put on the glue with a brush, afterwards sprinkle on the emery, and let it cool.

Cleaning Buff-coloured Leather.—One oz. oxalic acid dissolved in 1 pint water. Wash well, and then rub in a little clean tallow.

Boot and Shoe Making.—First get patterns. Some leather-sellers will cut the shoe or boot out if you take a last; but the surest way is to take an old shoe or boot to pieces. Get one the pattern and size required, put the pieces in water to soften them, open them out, and lay them on thick paper, and cut pieces of paper the size of the leather, tack these pieces of leather together with small steel tacks, or fasten them with paste, that made with rye flour is best; then close or stitch them together, holding them between the knees with clamps. Next get the last the size of the shoe. Procure some insole leather, soak in water, place the last on the smooth side, mark the leather round the size of the last; then cut the pieces off exactly by the mark, place the smooth side on the last, tack on with 3 or 4 tacks, press it close to the last, and while wet trim the insole close to the last all round. The shape of the shoe depends on this. Trim the rough off the bottom of the insole. Some shoemakers make two slight nicks round the insole, one about ¼ of an inch from the edge, the other about ½ an inch. Putting the awl in at one and out at the other of these nicks, it will sew more level, and the stitches are not so liable to break their hold of the leather. Next place the top level and straight on the last, get the pliers, and pull tight over the toe; drive a tack in the centre of the toe,

and one in the heel. Shoemakers generally push some bits of leather betwixt the last and the top leather on the instep, according to the size of the foot round the instep. Next, tack the top all round, then get a piece of top leather about an inch broad that will reach round the heel. Then place the heel of the shoe towards you, holding it on the knee with a strap, which goes under your foot and over the shoe. Sew round the heel first, put the awl in at the insole, but not too deep; sew the narrow piece round the heel, leaving enough to turn over; this done, take a bit off the edge of the welt, and sew round the shoe, putting from 4 to 5 stitches to the inch; keep the welt level while sewing. Get a stick, make it flat at one end, work it round the shoe between the top and the welt; trim the welt round level, cut the leather level round the heel, turn the narrow piece of top leather over, and fasten down with a few stitches. Place the shoe on the rough side of the bottom leather, mark round, and cut off. Then put a piece of inferior leather to finish up the heel, hammer the bottom soles, fill up the middle with small bits, put on the sole, and tack down. Next stitch the sole on; place the awl through the welt, holding the shoe so as to stitch towards you; place the heel on, put the awl between the top and the narrow piece that is turned over and through the heel pieces; these being sewn on, get the sharp end of the hammer, and hammer round the edge of the sole, and welt while they are wet; this will make the edge better to finish. Trim the edges round when dry, being careful not to cut the top leather; scrape round and put ink on, let the ink dry, put the heel-ball on, and heat the iron hot enough to melt the ball, but not to burn the leather; rub up with a bit of old cloth. If required to make the bottom smooth, and put a polish on, cut a nick in the bottom sole to let the stitches in, then scrape the bottom, and file it and rub with sand-paper.

To Skin and Stuff Birds.—1. Suspend the body by a hook, so that both hands are at liberty. For small kinds a common fish-hook will answer, with the barb broken off, and a cord attached a foot or two in length. This may be inserted among the bones near the tail after the skin has been partly detached. Other implements required are the following;—A sharp knife, of almost any shape; but a surgeon's scalpel without a jointed handle is the best for small kinds, and the common butcher's knife which is of similar shape, for large ones. Strong, sharp-pointed scissors, and for large skins a pair of shears is often useful. Triangular glovers' needles for sewing up skins; two or three sizes. A pair of spring forceps, such as are used by surgeons, though not essential, are very useful. A tape measure, 3 to 6 feet long. A fine saw, or coarse flat file, to notch small bones before breaking them, so as to make them break evenly, or sharp-edged nippers. Large bones may be broken roughly, and the ends smoothed off. When a bird is shot all large holes must be plugged with cotton or paper, and this also inserted in the mouth and throat, so as to prevent the flow of blood or other fluids. Blood on the feathers may be absorbed by sprinkling with plaster of Paris, ashes, dust, or sand, shaking off all that does not stick; then make a cone of paper, large enough to put the bird in, head down, and to twist up the other end over it, taking care not to injure the tail feathers. This will secure smoothness of the feathers when the body stiffens. In cool weather it is best to postpone skinning for 12 to 24 hours, in order to allow the blood to coagulate, so that it will not flow so freely, and the fat hardening also gives less trouble. Obtain its exact girth, so that it can be stuffed out to the same dimensions afterwards. Before skinning, put fresh plugs in the mouth, nostrils, and large shot-holes. Take the measurements and notes required. Then make an incision from the breast-bone down to the tail, not so deep as to open the intestinal cavity, and carefully separate the skin on each side, plugging or sewing up any holes accidentally cut too deep. If blood or fluids

run too freely, absorb them by some dry ashes, plaster, or paper, and use them so as to protect the feathers; if necessary keep the fingers well powdered. Separating the skin from one side, the leg is soon reached; this must be drawn out by the knee-joint as far as it can be, and the tendons cut where they go towards the foot. Break off the bone within the skin, and having freed that leg treat the other in the same way. It is most convenient in small birds to break these bones, and also those of the upper wing-joint, before beginning to skin, thus having the limbs less in the way. After the legs are freed, cut down to the tail, and separate from the body, leaving some of the vertebræ attached to support the feathers. Remove the oil-glands above the tail carefully from the skin, then insert the hook in the body and hang it up, head downwards. The skin is then easily peeled off until the wings are reached, when it must be drawn to one side until the broken end of the shoulder-bones are reached, which may be slipped through the muscles, and pulled out as far as possible. The muscles must then be cut off, and this wing being freed, the same process is used for the other. The skin then slips off easily so far as the head, which if large must be supported, so that its weight may not stretch the neck. In drawing the skin over the head be careful not to tear it, and use the finger-nails more than the knife. The ear membranes are easily drawn out with it, and on reaching the eyes the attachment of the lids must be carefully separated from the eyeball, cutting so as to injure neither the lids nor the eyeball, as the fluids escaping give trouble. Then cut off the back part of the skull, remove the brains and the eyes, clean away all remains from the skull, and sprinkle or smear the skin with arsenic, fill the eye-sockets and other cavities about the head with cotton or other stuffing, and draw the skin back to its original shape. If the neck has dried during the operation, it will need moistening before retraction. The second joints of the wings now require cleaning. This may be done in small birds by carefully drawing the skin down over the bones, loosening it with the finger-nails. Large birds, however, need an incision under the wing, reaching the whole length of the joint, which may be sewed up afterwards by a few stitches. Arsenic must be applied freely to all these parts. The wing-bones must now be connected by a string passed through the space between the bones, or a thread sewed through the ligaments so that it cannot slip. Do not draw the wings too close together, but leave as nearly the natural distance between them as is practicable. Cotton or tow may be now wound round the broken ends of the wing and leg bones, a roll of it inserted in the neck, and enough put in the body to fill it out to its natural shape. When the legs are tied together no stitches are generally necessary to sew up the cut. If there are large holes in the skin they should be sewed up from the inside before putting in the stuffing. In large birds it is well to sew on wide strips of rag along the inner edges of the cut made in the skin, to protect the feathers during the operation of skinning, removing the rags afterwards. Very badly-soiled skins can, however, be cleaned, and, provided they have not lost any feathers, are still useful. The bill should generally be tied shut by a string passed through the nostrils, and the label may be put there or on the legs. Very long necks are best stuffed by rolling up a long cylinder of paper and passing it down the throat or from the inside. The neck may then be bent down along the side of the body, and the legs bent up so as to make as compact a specimen as possible. Having smoothed down the feathers, the bird must now be pushed carefully inside a cylinder of stiff paper of the proper size, and laid on its back to dry. Hanging it up by the bill or feet stretches it too much. If carefully dried it retains a good shape, and may be freely handled afterwards. Some birds, especially ducks and woodpeckers, have the neck so slender that the head cannot be drawn through it by skinning in the usual manner. In these an incision must be made on the most injured side, from the ear down far enough to allow the head to be cleaned through it. The

body may then be skinned as usual, or the incision may be continued down the neck to the bare space under the wing, and the skin taken off without cutting it elsewhere. To sew this up requires care in order to adjust the feathers nicely, and the stitches must be taken from within outwards. There is much difference in the ease with which a bird may be skinned, according to the relative toughness of skin, and adhesion of feathers. A humming-bird is more easily skinned than a pigeon, and those of the size of a robin take much less time than an eagle. To practise on, the best are blackbirds and jays, those not too fat being preferable.

2. A very small proportion of the skull-bone, say from the fore part of the eye to the bill, is to be left in, as well as part of the wing-bones, the jaw-bones, and half of the thigh-bones. Everything else, flesh, fat, eyes, bones, brains, and tendons, are all to be taken away. In taking off the skin from the body it will be well to try to shove in lieu of pulling it, to avoid stretching it. Throughout the whole operation, as fast as you detach the skin from the body, put cotton immediately betwixt the body and it; this will prevent the plumage getting dirty. Have close by a little bottle of corrosive sublimate, also a little stick and a handful or two of cotton. Now fill the mouth and nostrils with cotton, and place it on your knee on its back, with its head pointed to your left shoulder. Take hold of the knife with the two first fingers and thumb, the edge upward; do not keep the point of the knife perpendicular to the body of the bird, because it would cut the inner skin of the belly, and let the bowels out. To avoid this let the knife be parallel to the body. Begin on the belly below the breast-bone and cut down the middle, quite to the vent. This done, put the bird in any convenient position, and separate the skin from the body, till you get at the middle joint of the thigh. Cut it through, and introduce cotton all the way on that side, from the vent to the breast-bone. Do exactly the same on the opposite side. Now place the bird perpendicular, its breast resting on your knee, with its back towards you. Separate the skin from the body on each side of the vent, and never mind at present the part at the vent to the root of the tail. Bend the tail gently down to the back, and while your finger and thumb are keeping down the detached parts of the skin on each side of the vent, cut quite across and deep, until you see the back bone near the oil-gland at the root of the tail. Sever the backbone at the joint, and then you have all the root of the tail, together with the oil-gland, dissected from the body. Apply plenty of cotton. Get the skin pushed up until you come to where the wing-joints join the body. Apply cotton, and then cut this joint through, and do the same at the other wing; add cotton, and gently push the skin over the head, cut out the roots of the ears, and continue skinning till you reach the middle of the eye; cut the membrane quite through, otherwise you would tear the orbit of the eye. After this nothing difficult intervenes before arriving at the root of the bill; when this is effected cut away the body, leaving just a little bit of the skull; clean well the jawbones, and touch the skull and corresponding parts with the solution. Now all that remains to be removed is the flesh on the middle joints of the wings, one bone of the thighs, and the fleshy root of the tail. Fasten thread to the joints of each wing, and then tie them together, leaving exactly the same space betwixt them as existed there when the bird was entire; hold the skin open with your finger and thumb, and apply the solution to every part of the inside. Neglect the head and neck at present. Fill the body moderately with wool to prevent the feathers on the belly from being injured. Half of the thigh, or in other words one joint of the thigh-bone, has been cut away. As this bone never moved perpendicularly to the body, but in an oblique direction, of course as soon as it is cut off, the remaining parts of the thigh and leg, having nothing to support them obliquely, must naturally fall to their perpendicular. Hence the legs

appear considerably too long. To correct this take a needle and thread, fasten the ends round the bone inside, push the skin just opposite to it, and then tack up the thigh under the wings with several strong stitches. This will shorten the thigh, and render it quite capable of supporting the body without the aid of wire. Now put in the cotton for an artificial body, by means of the little stick, and then sew up the orifice you originally made in the belly, beginning at the vent. Lastly, dip your stick into the solution, and put it down the throat three or four times, in order that every part may receive it. When the head and neck are filled with cotton close the bill as in nature. Bring the feet together by a pin, and then run a thread through the knees, by which draw them to each other as near as may be thought proper. Add the eyes; adjust the orbit to them as in nature, and that requires no other fastener. After this, touch the bill, orbit, feet, and former oil-gland at the root of the tail, with the solution. Procure a common box, fill one end of it, about three-fourths up to the top, with cotton, forming a sloping plane. Make a moderate hollow, and place the bird in its right position. If it is wished to elevate the wings, do so, and support them with cotton. If desired to have the tail expanded, reverse the order of the feathers, beginning from the two middle ones, and when dry place them in their true order, and the tail will preserve the expansion given to it. In three or four days the feet lose their natural elasticity, and the knees begin to stiffen. This is the time to give the legs any desired angle, and to arrange the toes. When the bird is quite dry, pull the thread out of the knees, and take away the needle, and all is done.

3. Previous to skinning take a piece of wire of suitable thickness, and measure from the centre of bill to tip of toes; have the wire twice that length, and double it in two, and point the double end with a hammer; do not separate them; point the other ends with a file. Having put in the eyes, and twisted some cotton on leg-bones, and filled up the aperture in skull with a piece of cork, thrust the double end of the wire through the cork, and let it enter the base of the beak; twist some cotton or tow round the wire to the same thickness and length as neck; then separate and form a shoulder on each wire, roll up some tow same size and shape as the bird's body, and twist some thread round it; thrust the wires through the tow body, one at each side; carefully turn the skin over your artificial body, in doing so place the wing-bones in their right place; pass the wires through the back of the legs, but inside the skin, add a little tow if required, sew up the aperture, and fix on stand by the wires; form a piece of wire into same shape as a hairpin, and pass under and through tail into the body to keep tail up; tie the bill with a piece of thread till it sets; give the bird the natural set, fix the wings in the right position, and pass a thread with a long needle through the body and last joints of wings and tie, not too tight, and tie tips of same at tail. Pay particular attention to the eyes, replace stray feathers with a needle, and brush down with a camel-hair brush.

Preservative for Bird-skins.—Ground alum, 4 parts; pepper and saltpetre, 1.

Lubricants.—The friction of the parts in machinery frequently absorbs a large percentage of the power employed. Various lubricating materials are used to reduce this source of waste. When polished steel moves on steel, or pewter properly oiled, the friction is about one-fourth of its weight; on copper or lead, one-fifth; on brass, one-sixth. Metals have more friction when they move on metals of the same kind than when on different metals. In wood rubbing upon wood, oil, grease, or black-lead, properly applied, reduces the friction two-thirds. Lard, oil, tallow, soap, black-lead, French chalk, and combinations of these substances, are used in different trades.

Antifriction Grease.—1. One part of fine black-lead, ground perfectly smooth, with 4 parts of lard. 2. Dissolve about

50 lbs. of soda in 3 or 4 gallons of boiling water, then melt in a copper about $1\frac{1}{2}$ cwt. of tallow or palm oil; after it has cooled a little pour in gradually the soda, stirring it all the while till it cools. 3. For cooling necks of shafts, which may occasionally be found useful where the shafts are not of a proper length, or the bearings faulty; 16 lbs. tallow, dissolved in a vessel; $2\frac{1}{4}$ lbs. white sugar of lead. When the tallow is melted, but not boiling, put in the sugar of lead and let it dissolve. Then put in 3 lbs. of black antimony. Keep stirring the whole mass till cold.

Lubricating Composition for Railway Axles.—In a small boiler dissolve from 56 lbs. to 60 lbs. of soda in about 3 galls. of water. In a 60-gallon boiler, melt tallow, and to it add palm oil, each in quantity, according to season. In summer weather, tallow 1 cwt. 3 qrs.; palm oil, 1 cwt. 1 qr. In winter, tallow 1 cwt. 1 qr.; palm oil, 1 cwt. 3 qrs. In spring or autumn, tallow, 1 cwt. 2 qrs.; palm oil, 1 cwt. 2 qrs. As soon as the mixture boils, put out the fire, and let the mixture cool down gradually, frequently stirring it while cooling. When reduced to blood heat, run it off through a sieve into the solution of soda, stirring it well, to ensure a perfect mixture of the ingredients.

Anti-attrition Paste.—Lard, $2\frac{1}{2}$ lbs.; camphor, 1 oz.; black-lead, $\frac{1}{2}$ lb.; rub the camphor in a mortar down into a paste, with a little of the lard; then add the rest of the lard, and the black-lead, and mix thoroughly.

A good Lubricating Oil that will not thicken.—Take olive oil, and dissolve it in boiling alcohol, add it drop by drop to the hot alcohol, until it is no longer taken into solution. Upon cooling, it will let fall crystals, and leave a considerable portion still fluid; the fluid part is to be poured off, filtered through a piece of white blotting paper, and either used in this form, or the alcohol may be distilled off for fresh processes, and the pure lubricating oil which will remain can be obtained for oiling watches and delicate machinery. This will not oxidize or gum up, and will remain perfectly fluid even when exposed to great cold.

Watchmakers' Oil.—1. Take neat's-foot oil, and put into it some lead shavings in order to neutralize the acid contained in the oil; let this stand for a considerable time, the longer the better. Oil thus prepared never corrodes, or thickens. 2. Get the best olive oil, stir it up for some time with water kept at the boil, then, after separation, shake it up in a bottle with a little fresh lime, and allow them to stand for some weeks in a bottle exposed to the sunlight and air, but protected from wet and dirt. When filtered off it will be nearly colourless, perfectly limpid, and will never thicken or become rancid. 3. Procure 1 quart of olive oil, put it into a cast-iron vessel capable of holding 2 quarts, place it over a slow, clear fire, keeping a thermometer suspended in it, and when the temperature rises to 220°, check the heat, never allowing it to exceed 230°, nor descend below 212° for one hour, by which time the whole of the water and acetic acid will be evaporated; the oil is then exposed to a temperature of 30° to 36° for 2 or 3 days; then pour the oil on a muslin filter to allow the fluid portion to run through; lastly, the fluid portion must be filtered once or more through newly-prepared animal charcoal, coarsely powdered, and placed on bibulous paper in a wire frame within a funnel, by which operation rancidity is entirely removed, and the oil is rendered perfectly bright and colourless.

Belgian Antifriction Metal.—For parts exposed to much friction, 20 parts copper, 4 of tin, 0·5 of antimony, 0·25 lead. For parts subjected to great concussions, 20 parts copper, 6 zinc, 1 tin. For surfaces exposed to heat, 17 parts copper, 1 zinc, 0·5 tin, 0·25 lead. In making these alloys, mix all the other ingredients before adding the copper.

Lard Oil Refining.—Agitate the lard oil with a ley of caustic potash of specific gravity 1·2. A sufficient quantity is known to have been added when, after repose, a portion begins to settle down clear at the bottom; about 4 to 8 per cent. is usually required. After 24 hours' repose, the clear supernatant oil

is decanted from the soapy sediment and filtered; it may be thoroughly bleached by a mixture of bichromate of potassa, and sufficient hydrochloric acid to seize on all the alkali and liberate the chromic acid.

Galvanizing Iron.—Sheet iron, iron castings, and the like, are first cleaned and scoured by immersion in a bath of water, acidulated with sulphuric acid, heated in a leaden vessel, or used cold in a wooden one, to remove the oxide. The pieces are then thrown into cold water, and taken out one at a time to be scoured with sand and water with a piece of cork or the husk of the cocoa-nut, the ends of the fibres serving as a brush. The pieces are then returned to cold water. Pure zinc, covered with a thick layer of sal ammoniac is then melted in a bath, and the iron, if in sheets, is dipped several sheets at a time in a cradle or grating. The sheets are raised slowly to allow of draining, are then immediately thrown into cold water; on removal, the work is finished by wiping dry. Thick pieces are heated in a reverberatory furnace before being placed in the bath, to prevent cooling the zinc. Chains are similarly treated, and on removal from the zinc are shaken until cold to avoid soldering of the links together. Nails and small articles are dipped in muriatic acid, and dried in a reverberatory furnace; next, thrown into zinc covered with sal ammoniac, left for a minute, and taken out slowly with an iron skimmer; they come out in a mass soldered together, and to separate them are placed in a crucible surrounded with charcoal powder, then heated to redness and shaken about until cold for separation. Wire is reeled through the zinc, into which it is forced to dip by a fork or other contrivance. The zinc is melted in a crucible just a little beyond the point of fusion, and is always covered with a thick coat of sal ammoniac, for the purposes of preventing waste of zinc and preparing the metal to be covered. Wrought-iron baths welded at the angles succeed much better than cast-iron, lined with clay. By another system the sheets of iron are pickled, scoured, and cleaned just as for ordinary tinning. A large wooden bath is then half filled with a dilute solution of muriate of tin, prepared by dissolving metallic tin in concentrated muriatic acid, which takes 2 or 3 days, and 2 quarts of the saturated solution are added to 300 or 400 gallons of the water contained in the bath. Over the bottom of the bath is spread a thin layer of finely-granulated zinc, then a cleaned iron plate, and so on—a layer of finely-granulated zinc and a cleaned iron plate alternately, until the bath is full; the zinc and iron, together with the fluid, constitute a weak galvanic battery, and the tin is deposited from the solution, so as to coat the iron with a dull uniform layer of metallic tin in about 2 hours. Whilst this is being done, a wrought-iron bath, containing fluid zinc, is being prepared, the melted metal is covered with sal ammoniac, mixed with earthy matter, to lessen the volatilization of the sal ammoniac, which becomes as fluid as treacle. Two iron rollers, immersed below the surface of the zinc, are fixed to the bath, and are driven by machinery to carry the plates through the fluid metal at a determined velocity. The plates are now received one by one from the tinning bath, drained for a short time, and passed at once, still wet, through the zinc, by means of rollers; the plates thus take a regular and smooth layer of zinc, which, owing to the presence of tin beneath, assumes the natural crystalline character, giving the plates the well-known moire appearance.

Cleaning Galvanized Vessels.—The simplest plan is to scour them with a strong solution of hot water and common washing soda; but if used for hot water and soap, use best tinned vessels, or have them painted, as galvanized iron attracts soap in such a manner as to cause a deposit which is disagreeable and unsightly.

Silvering and Tinning.—*To Silver by Heat.*—1. Dissolve 1 oz. of pure silver in aquafortis, and precipitate it with common salt; to which add ½ lb. of

sal ammoniac, the same of white vitriol, and ¼ oz. of corrosive sublimate. 2. Dissolve 1 oz. of pure silver in aquafortis; precipitate it with common salt, and add, after washing, 6 oz. of common salt, 3 oz. each of sandiver and white vitriol, and ¼ oz. of sublimate. These are to be ground into a paste upon a fine stone with a muller; the substance to be silvered must be rubbed over with a sufficient quantity of the paste, and heated. When the silver runs, it is taken from the fire, and dipped into weak spirit of salt to clean it.

To Silver in the Cold Way.—1. 2 dr. tartar, 2 dr. common salt, ½ dr. of alum, and 20 grs. of silver, precipitated from the nitrous acid by copper. Make into a paste with a little water. This is to be rubbed on the surface to be silvered with a cork. 2. Dissolve pure silver in aquafortis, and precipitate the silver with common salt; make this precipitate into a paste by adding a little more salt and cream of tartar. It is applied as in the former method.

To Silver Copper Ingots.—The principal difficulties in plating copper ingots are, to bring the surfaces of the copper and silver into fusion at the same time, and to prevent the copper from scaling; for which purposes fluxes are used. The surface of the copper on which the silver is to be fixed must be made flat by filing, and should be left rough. The silver is first annealed, and afterwards pickled in weak spirit of salt; it is planished, and then scraped on the surface to be fitted on the copper. These prepared surfaces are anointed with a solution of borax, or strewed with fine powdered borax itself, and then confined in contact with each other by binding wire. When they are exposed to a sufficient degree of heat, the flux causes the surfaces to fuse at the same time, and when cold they are firmly united. Copper may likewise be plated by heating it, and burnishing leaf-silver upon it; so may iron and brass.

To Plate Iron.—1. Polish the surface very clean and level with a burnisher; then expose it to a blueing heat; a leaf of silver is to be properly placed and carefully burnished down. This is repeated until sufficient leaves are applied to give the silver a proper body. 2. By solder; slips of thin solder are placed between the iron and silver, with a little flux, and secured together by binding wire. Then place in a clear fire until the solder melts; when it is taken out, on cooling, it will adhere firmly. 3. By tinning the iron first, and uniting the silver by means of slips of rolled tin, brought into fusion in a gentle heat.

To Tin Copper and Brass.—Boil 6 lbs. of cream of tartar, 4 galls. of water, and 8 lbs. of grain tin or tin shavings. After the materials have boiled a sufficient time, the substance to be tinned is put therein, and the boiling continued, when the tin is precipitated in its metallic form.

To Tin Iron and Copper Vessels.—Iron which is to be tinned must be previously steeped in acid materials, such as sour whey or distillers' wash; then scoured and dipped in melted tin, having been first rubbed over with a solution of sal ammoniac. The surface of the tin is prevented from calcining by covering it with a coat of fat. Copper vessels must be well cleansed; and then a sufficient quantity of tin with sal ammoniac is put therein and brought into fusion, and the copper vessel moved about. A little resin is sometimes added. The sal ammoniac prevents the copper from scaling, and causes the tin to be fixed wherever it touches.

To Tin Brass or Copper.—1. Plates or vessels of brass or copper, boiled with a solution of stannate of potassa mixed with turnings of tin, become, in the course of a few minutes, covered with a firmly-attached layer of pure tin. 2. A similar effect is produced by boiling the articles with tin filings and caustic alkali, or cream of tartar. In the above way chemical vessels made of copper or brass may be easily and perfectly tinned.

Tinning Iron Saucepans.—If the saucepan is an old one it must be put on the fire and allowed to get nearly red hot, which will get rid of all the grease; then make a pickle of the following proportions;—Oil of vitriol, ½ lb.; muriatic acid, ¼ lb.; water, 1 gall. If the sauce-

pan can be filled so much the better, if not keep the pickle flowing over it for say 5 minutes, pour out, rinse with water, and scour well with sand or coke dust with a wisp of tow, rinse well with water; if the pan is clean it will be of an uniform grey colour, but if there are any red or black spots it must be pickled and scoured again till thoroughly clean. Have ready chloride of zinc, that is, muriatic acid in which some sheet zinc has been dissolved, some powdered sal ammoniac, some tow, about 18 inches of iron rod of about $\frac{1}{4}$ or $\frac{3}{8}$ inch thick, one end flattened out and bent up a little and filed clean, and some bar tin; dip a wisp of tow in the chloride of zinc, then into the powdered sal ammoniac, taking up a good quantity, and rub well all over the inside. This must be done directly after the scouring, for if allowed to stand it will oxidize; put on the fire till hot enough to melt the tin, the end of the bar of tin being brushed over the heated part till melted; run down about half the bar, and with the flatttened end of the iron rod rub the tin well over the surface, taking care not to heat too large a surface at once, nor to let it get too hot, which may be known by the tin getting discoloured, when some dry sal ammoniac must be thrown in. Having gone all over it, wipe lightly with a wisp of tow, just made warm enough that the tin does not stick to it; when cold scour well with sand and tow, rinsing with plenty of water.

Tinning Brass Wire.—Have two baths, one containing the molten tin, kept at a proper temperature, the other a saturated solution of chloride of zinc. Immerse the coil of brass wire in a boiling solution of caustic potash, and remove it to a bobbin, having a fixed spindle and one movable end. Pass the wire by means of suitable hard wood or brass deeply-grooved pulleys, so that it shall pass through the chloride of zinc bath into the molten tin, and after immersion cause it to pass between the grooves of two pulleys, revolving in contact with each other, so that the grooves form a hole equal in size to the tinned wire; these will squeeze off any superfluous metal that may be carried up from the bath; carry forward the end and attach to it a fresh bobbin, and wind off at a speed that must be regulated by experience. The wire must be raised sufficiently in temperature before it will take the tin, and it must be properly cooled again before it reaches the final bobbin, which can be effected by placing it at a proper distance from the tin bath.

Cold Tinning.—Block tin dissolved in muriatic acid with a little mercury forms a very good amalgam for cold tinning; or, 1 part of tin, 2 of zinc, 6 of quicksilver. Mix tin and mercury together until they form a soft paste. Clean the metal to be tinned, taking care to free it from greasiness; then rub it with a piece of cloth moistened with muriatic acid, and immediately apply a little of the amalgam to the surface, rubbing it in with the same rag. The amalgam will adhere to the surface and thoroughly tin it. Cast iron, wrought iron, steel, and copper may be tinned this way. Those who find it difficult to make soft solder adhere to iron with sal ammoniac, will find no difficulty if they first tin the surfaces in this manner, and then proceed as with ordinary tin plate.

Tinning Cast and Wrought Iron Pipes.—File bright the piece of iron required to be tinned, and mix up the following solution;—In a pennyworth of spirits of salts, put a piece of zinc the size of a shilling, the spirits of salts will eat it away; wet the places required to be tinned with the solution, then while wet use a copper-bit with fine solder, and it will immediately tin.

Crystallized Tin-Plate is a variegated primrose appearance, produced upon the surface of tin-plate, by applying to it in a heated state some dilute nitro-muriatic acid for a few seconds, then washing it with water, drying, and coating it with lacquer. The figures are more or less diversified, according to the degree of heat, and relative dilution of the acid. Place the tin-plate, slightly heated, over a tub of water, and rub its surface with a sponge dipped in a liquor composed of 4 parts of aquafortis, and 2 of distilled

water, holding 1 part of common salt or sal ammoniac in solution. When the crystalline spangles seem to be thoroughly brought out, the plate must be immersed in water, washed either with a feather or a little cotton, taking care not to rub off the film of tin that forms the feathering, forthwith dried with a low heat, and coated with a lacquer varnish, otherwise it loses its lustre in the air. If the whole surface is not plunged at once in cold water, but is partially cooled by sprinkling water on it, the crystallization will be finely variegated with large and small figures. Similar results will be obtained by blowing cold air through a pipe on the tinned surface, while it is just passing from the fused to the solid state.

Cleaning Tinware.—Acids should never be employed to clean tinware, because they attack the metal, and remove it from the iron of which it forms a thin coat. We refer to articles made of tinplate, which consists of iron covered with tin. Rub the article first with rottenstone and sweet oil, the same as recommended for brass, then finish with whitening and a piece of soft leather. Articles made wholly of tin should be cleaned in the same manner. In a dry atmosphere planished tinware will remain bright for a long period, but it soon becomes tarnished in moist air.

Tinning Small Articles.—Place them in warm water, with a little sulphuric acid added to it, which will clean them; then powder some sal ammoniac and mix it in the water, stirring well until all is dissolved. After washing the articles in clean water, place them in the solution for a few minutes; then lay them by the fire to dry. Procure a pan resembling a frying pan in shape, the bottom of which must be full of small holes. The pot for melting the tin must be large enough to admit the pan for holding the articles. Cover the bottom of the pan with the articles to be tinned, and, after sprinkling a little powdered sal ammoniac over the surface of the molten tin to clear it from dross, dip the pan containing the goods into it; after all smoke has disappeared, lift it out and shake well over the pot, sprinkling a little sal ammoniac over the goods to prevent them from having too thick a coat, then cool quickly in cold water to keep them bright.

Annealing Steel.—Make the steel red hot, then put it in a heap of dry saw-dust till cold, when it will be found to be quite soft.

Mother-of-Pearl. — Mother-of pearl is the inner coat of several kinds of oyster-shells, some of which secrete this layer of sufficient thickness to render the shell an object of manufacture. The beautiful tints of the layer depend upon its structure, the surface being covered with a multitude of minute grooves, which decompose and reflect the light. The structure of the pearl shell admits of its being split into laminæ, and it can then be used for the handles of knives, for inlaying, or in the manufacture of buttons; but as splitting is liable to injure or spoil the shell, this method of dividing it is seldom resorted to. In manufacture the different parts are selected of a thickness as nearly as possible to suit the required purpose; excess of thickness is got rid of by means of saws, filing, or by grinding upon the common grindstone. In preparing the rough shell, if square or angular pieces are needed, they are cut with saws, as the circular saw or the ordinary back saw; in the one case, the shell is fed up as the saw divides it, and in the other the shell is held in a vice, and the saw operated by hand. If circular pieces of the shell are wanted, such as those for buttons, they are cut with an annular or crown saw, which is fixed upon a mandrel. It is necessary in sawing that water is plentifully supplied to the instrument, or the heat generated by dividing the shell will heat the saw, and its temper will be destroyed. The pieces of shell are next ground flat upon a grindstone, the edge of which is turned with a number of grooves or ridges, as being less liable to become clogged than the entire surface, and hence grind more quickly. It is necessary to supply water, or soap and water, to the stone, as it is then less liable to become clogged. The flat side of the stone, similarly prepared with ridges, may be used instead of the face, if it is desired to

have the pieces of shell ground flat, and when of the requisite thinness they are ready for operation in the lathe, or for inlaying. After the pieces of pearl shell are cut, ground, or turned to the proper form, they are finished with pumice-stone and water; this may be done with pieces of the stone properly shaped, and rubbed over the work as it is held fast in some form of clamp, or held upon the work as it is revolved in the lathe. This process may be followed by an application of ground pumice-stone, which has been carefully sifted to extract all except the minutely powdered portion, and applied with a piece of cork or a cloth moistened with water. The polishing is accomplished with rotten-stone, moistened with dilute sulphuric acid, which may be applied upon a piece of cork or a bit of soft wood. In some turned works fine emery paper may be used, and followed with rotten-stone moistened with the acid or oil. The pearl handles used for razors or knives are first roughed out, then drilled where the rivets are to be inserted, and lightly riveted together in pairs. They are ground to the proper size and thickness, and finished by the means mentioned, the last finishing touch, to produce a fine polish, often being done by the friction of the hand of the workman. Sometimes it is advantageous to apply the polishing material to the surface of a wheel, and this wheel may be covered with cloth and moistened with water, which will cause enough of the powder to adhere. Separate wheels may be used for the pumice-stone and the rotten-stone. Sometimes dry powdered chalk or Spanish whiting is used in place of the rotten-stone. One process of working pearl is by the aid of corrosive acids and the etching point. The shell is first divided as may be necessary, and the designs or patterns drawn upon it with an opaque varnish; strong nitric acid is then brushed over the plates repeatedly, until the parts undefended by the varnish are sufficiently corroded or eaten away by the acid. The varnish now being washed off, the device, which the acid had not touched, is found to be nicely executed. If the design is to be after the manner of common etching on copper, the process upon the shell is precisely the same as that process upon metal. When a considerable number of pieces of thin shell are required to be of the same size and pattern, the requisite number of plates are cemented together with glue, and the device or figure drawn upon the outer plate. They may then be held in a vice or clamp, and cut out as one plate with a fine saw, or wrought into the desired form with files; drilling tools may be employed to assist in the operation. To separate the pieces, the cemented shells are thrown into warm water, which softens the glue and separates the pieces.

Artificial Mother-of-Pearl Buttons.—White horn buttons may be made to imitate mother-of-pearl by being boiled in a saturated solution of sugar of lead, and then laid in very dilute hydrochloric acid. Combs, to which the boiling process is not applicable, as it distorts the teeth, may be treated by being kept overnight in a moderately concentrated cold solution of nitrate of lead, then laid for a quarter to half an hour in a bath containing 3 per cent. of nitric acid, and finally being rinsed in water. The use of sugar of lead is, however, prejudicial, and should be avoided.

Inlaying with Mother-of-Pearl. — 1. Tortoiseshell is softened by soaking it in hot water—the design arranged, and placed between flat dies, under a heavy press, to remain till the shell is cold and dry. It is thus embedded in the shell. Those vivid colours on paper trays are fragments of the Aurora shell, pressed in the same way, while the paper is damp; when dry the design is painted, varnished, baked, and polished.

2. Thin scales of the shell are to be selected for their colour, or shade, and cemented to the surface of the material. The rest of the surface is covered with successive coats of japan varnish, generally black, being subjected to a baking process after each application. When the varnish is as thick as the shell it is polished, the gilding and painting added, and a flowing coat of varnish put over the whole.

To Imitate Tortoiseshell with Horn.—1. Mix up an equal quantity of quick lime and red lead with soap lees; lay it on the horn with a small brush, in imitation of the mottle of tortoiseshell; when it is dry, repeat it two or three times. 2. Grind 1 oz. of litharge and ½ oz. of quick lime, together with a sufficient quantity of liquid salts of tartar to make it of the consistence of paint. Put it on the horn with a brush, in imitation of tortoiseshell, and in three or four hours it will have produced the desired effect; it may then be washed off with clean water; if not deep enough it may be repeated. 3. Take a piece of lunar caustic about the size of a pea; grind with it water on a stone, and mix with it a sufficient portion of gum arabic to make it of a proper consistence; then apply it with a brush to the horn in imitation of the veins of tortoiseshell. A little red lead, or some other powder mixed with it, to give it a body, is of advantage. It will then stain the horn quite through, without hurting its texture and quality. In this case, however, you must be careful, when the horn is sufficiently stained, to let it be soaked for some hours in plain water, previous to finishing and polishing it. Pieces of horn are united together to form one large piece by being softened at the edge by boiling water, and then pressing them together powerfully while surrounded by boiling water.

Preparation of Horn.—The horn is first roasted over a fire made of the stalks of furze. When rendered soft, it is slit on one side, and kept expanded flat between a pair of tongs; it is then placed in a press between iron plates which are greased. The horns are suffered to remain till they are cooled; they are then soaked in water till soft enough to be pared down to the required thinness, with a large knife worked horizontally on a block. Their transparency is thus acquired; and after being immersed in ley, they are polished with whitening and the coal of burnt willow.

Gum.—*Mucilage for Labels.*—Macerate 5 parts of good glue in 20 parts of water for 24 hours, adding 20 parts of rock candy, and 3 parts of gum arabic.

To Preserve Gum-Arabic Solutions.—A few drops of oil of cloves, or of alcohol, or any essential oil, will preserve a quart of the mucilage of gum arabic or gum tragacanth from turning sour. A small quantity of dissolved alum will preserve flour paste.

Artificial or British Gum.—Malt, crushed small, 1 lb.; warm water, 2 galls. Mix; heat the whole to 145° Fahr.; add of potato starch 5 lbs.; raise the heat to 160° Fahr., and mash for about 25 minutes, or until the liquid becomes thin and clear; it must then be instantly run off, and raised to the boiling point to prevent the formation of sugar; after boiling for 3 or 4 minutes, the whole must be filtered and evaporated to dryness by a steam heat.

Wax Impressions from Seals.—Warm the seal a little, and rub over it the end of a wax candle; then sprinkle it with the best vermilion. Melt the sealing wax by holding it over a candle, so that it does not catch fire—suffering it to drop upon the paper; impress the prepared seal upon it, and if done carefully a fine impression will be made. If several seals are to be made at once, or even one of a large size, it is customary to melt the sealing wax in a small ladle or crucible, from which it may be poured as wanted. Seals of different colours are made by dusting the seal with a powder of one colour, and stamping it upon wax of another; thus dust the seal with lampblack, and impress it upon red wax—the impression will have a black centre and red edge.

To make Glass Seals.—First, procure a mould made of plaster of Paris, the counterpart of the seal wished for, and this may be made by pouring a mixture of plaster of Paris and water, of the consistency of cream, upon any engraved seal, previously slightly oiled; when set, remove the cast and let it thoroughly dry, when it will be fit for use; then place in the centre of a clear fire a piece of flint glass, holding it with a pair of iron pincers, being careful to hold it so as not to touch any of the black coals.

When of a red, or still better of a white heat, take it from the fire, lay it upon the mould, and press upon the back of it so as to force it into all the depressions. To finish it, it requires to be ground round the edge into shape. If it be desired to imitate a sealing-wax impression, it is necessary to oil it, pour common wax upon it, and take the plaster cast from this. The makers of composition seals usually melt the glass in a crucible, taking out a sufficient quantity with an iron rod. Their moulds have a ridge or frame of plaster round them, to ensure the proper shape at once, without after grinding.

Gum Seals are made by pouring a little strong gum water over the impression, after being oiled slightly, and keep adding more as it dries. When about the consistence of india-rubber, it can be taken off with an open penknife.

Manufacture of Glue; *from Bones.*—The first process is to cleanse the bones by immersing them in a pit or cistern of water, where they remain about 12 hours; the water is then to be drawn off, and fresh water added to them; this operation is sometimes repeated to remove any dirt. The water being withdrawn from the bones, a solution of lime, in the proportion of 1 bushel of lime to 500 gallons of water, is to be poured into the cistern for the more perfect cleansing of the bones and the removal of any superfluous matter. After 3 or 4 days' saturation the lime solution should be drawn off and fresh water added to get rid of the lime. Thus prepared, the bones are placed in a hollow globular vessel of wrought iron, called an extractor, which is filled with them by removing the interior plate which covers the manhole; this aperture is of an elliptical form, and allows the plate to be slipped round and refixed in its place by turning a nut, which draws it up tight against the interior surface of the extractor, and the junctures are made air-tight by luting. The extractor turns upon a horizontal cylindrical shaft; one half of this shaft is made hollow, or consists of a strong tube, which tube also proceeds downwards towards the centre of the vessel to conduct the steam beneath the grating upon which the bones are laid. The steam, of about 15 lbs. pressure, is admitted by the cylindrical shaft, proceeds first to the bottom of the extractor, then rises up through the grating and amongst the bones, until the vessel is completely charged; previous to this, however, the air in the extractor is got rid of by opening a cock at the top of the extractor, and closing it after the admission of steam. While the steam is acting upon the bones the extractor is occasionally turned round by means of a hand-winch. When at rest, a quantity of fluid gelatine is collected at the bottom of the extractor, from whence it is discharged by means of a cock into a tub beneath, after opening the air-cock to enable it to run off. This done, steam is again admitted from the boiler into the extractor to act upon the bones for another hour, when the second portion of condensed liquor is drawn off. When the products thus obtained have become cold, the fat which has formed upon the surface is to be carefully removed by skimming, and the gelatinous portion only is to be returned into the extractor by means of a funnel through the cock on the top. The steam is then admitted to the extractor for an hour, after which it is finally drawn off into another vessel to undergo a simple evaporating process until it arrives at a proper consistency to solidify when cold, previous to which some alum is added to clarify it. When cold this gelatinous mass is cut out into square cakes, and dried as usual in the open air.

Common Glue.—1. Common glue is extracted from hoofs, horns, and cuttings of the hides of various animals. For this process the materials are first steeped in water for 2 or 3 days, well washed, and afterwards boiled to the consistency of a thick jelly, which is passed while hot through osier baskets to separate the grosser particles of dirt or bones from it, and allowed to stand some time to purify further. When the remaining impurities have settled to the bottom, it is melted

and boiled a second time. It is next poured into flat frames or moulds, from which it is taken out hard and solid, and cut into square pieces or cakes, and afterwards dried in the wind in a coarse kind of net. 2. Substances intended for the glue-maker are macerated with milk of lime for 14 days, and dried by exposure to the air; they can then be transported to any distance without undergoing decomposition. The manufacturer generally treats the materials again with dilute milk of lime; afterwards they are carefully washed and exposed to the air for about 20 or 30 hours. They are then placed in a copper boiler having a perforated false bottom, which supports the materials and prevents their being burnt; the boiler is filled about two-thirds with water, and is piled up with the animal substances until they are level with the brim; a gentle but steady boil should be maintained, and the substances should be stirred from time to time. When the liquor on cooling forms a firm gelatinous mass, the clear portion is run off into another vesssel, and a small quantity of dissolved alum is added. It is kept warm by means of hot water, and allowed to remain undisturbed for some hours to deposit its impurities; it is next run into the congealing boxes, and left to cool. When cold the masses are turned out upon boards wetted with water, cut into small cakes, and these cakes are placed upon nettings to dry. The dry cakes are then dipped into hot water, and lightly rubbed with a brush to give them a gloss, and lastly stove-dried for sale. This furnishes the best and palest glue. After the first liquor is drawn from the copper, the remnants left in the boiler are treated with fresh water, again and again, until no gelatinous matter can be extracted.

Gelatine.—Gelatine is made by steeping the stomach and intestines of fish in cold water, and then gently boiling them into a jelly; this is spread into sheets and allowed to dry. The air-bladder of the sturgeon makes the true isinglass.

Bleaching Wax.—The process of bleaching wax consists in first melting it at a low temperature in a caldron, from whence it is allowed to run out by a pipe at the bottom into a capacious vessel filled with cold water, in which is fitted a large wooden cylinder that is made to turn on its axis, upon which the melted wax falls. The surface of the cylinder being constantly wet, the wax does not adhere to it, but lays solid in the form of ribbons as fast as they are formed, and distributed through the tub. The wax is then put upon large frames covered with linen cloth, which are supported about 18 in. above the ground, in a situation exposed to the air, dew, and sun. The thickness of the several ribbons thus placed on the frame should not exceed 1½ in., and they ought to be moved from time to time that each part may be equally exposed to the action of the air. If the weather is favourable it will become white in a few days. It is then remelted, formed into ribbons, and exposed to the air as before. These operations are repeated until the wax is rendered perfectly white; after which it can be melted and run into cakes. Sometimes it is bleached by the following chemical process;—The wax is heated to about 212° Fahr. in an iron vessel lined with lead, when either chloride of lime or magnesia is added, either in solution with water or in a dry state, and then intimately mixed and stirred up with a wooden spatula. When these materials have acted on each other for a sufficient length of time to discharge the colour from the wax, the lime or magnesia is removed by the addition of dilute sulphuric acid, which possesses a greater affinity for those alkalies than chlorine. The whole is then to be boiled until all the alkalies employed are separated. The solution of the chloride is to be in the proportion of from 14 lbs. to 28 lbs. of the salt to 112 lbs. of water, and an equal quantity by weight of the melted wax. The sulphuric acid should be of the specific gravity 1·8, and be diluted with twenty times its weight of water.

Inks.—The composition of ink varies according to the purposes for which it is intended, and the large number of uses to which it is now applied, such as for writing, printing, lithography, and engraving, necessitate very great nicety in its proportions, and care in its preparation. A good ink ought to be so thin as to flow freely from the pen; it should be so thick as not to spread or blur on the paper, and it should possess sufficient depth of colour to retain its blackness for many years. Much of the permanency of ink depends on the material upon which it is written, for if we write on paper which has been bleached with chlorine, and the gas has been imperfectly removed, it has a deleterious effect on the beauty and durability of the writing. Concerning the composition of ink, galls are used in the process, not because they are rich in gallic acid, but because they contain a high percentage of tannic acid.

Black Writing Inks.—The proportions which appear most suitable, and upon which most dependence can be placed, are—1. bruised galls, 1 lb.; to this add 1 gallon of boiling water, and one-third of the weight of the galls, namely, 5½ oz. of sulphate of iron in solution; also 3 oz. of gum arabic previously dissolved, and a few bruised cloves or a few drops of creosote or carbolic acid dissolved in methylated spirit. It is better to allow the galls to macerate for 24 hours, then strain the infusion, and add the other ingredients. 2. Take of bruised galls 12 oz., macerate for a week in 1 gallon of cold water, then add 6 oz. of sulphate of iron in solution, also 6 oz. of mucilage of gum arabic, and 5 or 6 drops of creosote. 3. 12 lbs. Aleppo galls bruised, boiled in 6 gallons soft water for an hour, adding water to replace that evaporated; strain, and again boil the galls in 4 gallons more water for about half an hour; strain and boil with 2½ gallons more water; strain, and mix the liquors. Add 4½ lbs. coarsely-powdered green copperas, 4 lbs. gum arabic in small pieces, agitate until the ingredients are dissolved, filter through a hair sieve. This will yield about 12 gallons of very fine durable ink.

Copying Ink.—1. Add 1 oz. of lump sugar, or of sugar-candy, to 1½ pint good black ink, dissolve. The following requires no press, but may be copied by placing a damp sheet of copying paper on the writing intended to be copied; above this sheet of copying paper a sheet of ordinary writing paper must be placed, and then rubbed over with a paper knife. 2. Mix 30 grains of extract of logwood; 7 grains of crystal soda; ½ oz. of water. Boil till dissolved; then, while stirring well, add 30 grains of glycerine, 1 grain of chromate of potash, previously dissolved, and 4 grains of powdered gum arabic. 3. A transfer ink, for copying without any press, and without previously moistening the copying paper, consists of a decoction of Brazil wood and glycerine. When paper is written upon with the ink, and laid on tissue paper, rubbing with the finger transfers it.

Blue-black Writing and Copying Ink.—Blue Aleppo galls, free from insect perforation, 4½ oz.; bruised cloves, 1 dram; cold water, 40 oz.; purified sulphate of iron, 1½ oz.; pure sulphuric acid, by measure, 35 minims; sulphate of indigo, in the form of a thin paste, and which should be neutral, or nearly so, ¼ oz. Place the galls, when bruised, with the cloves, in a 50-oz. bottle, pour upon them the water, and digest, shaking daily for a fortnight. Then filter through paper into another 50-oz. bottle. Get out the refuse of the galls, and wring out of it the remaining liquor through a strong clean linen or cotton cloth into the filter, in order that as little as possible may be lost. Next put in the iron, dissolve completely, and filter through paper. Then the acid, and agitate briskly. Lastly, the indigo, and thoroughly mix by shaking. Pass the whole through paper. Filter out of one bottle into the other till the operation has been completed. When intended for copying, 5½ oz. galls is the quantity. The water should be as soft as possible—that is, it should contain

no lime or other earthy matter; rain water, or distilled water, should be used in making ink.

Black Ink, Non-corrosive.—Digest in an open vessel, 42 oz. of coarsely-powdered nut-galls, 15 oz. of gum senegal, 18 oz. of sulphate of iron, free from copper; 3 drams of aqua ammonia; 24 oz. of alcohol; and 18 quarts of distilled or rain water. Continue the digestion until the fluid has assumed a deep black colour. For cheap inks other ingredients may be substituted instead of part of the galls; logwood, catechu, sumach, and oak bark may be used for the same purpose. Many other substances, such as elm wood, elder, chestnut, beech, willow, plum, cherry, and poplar, all contain a certain amount of astringent properties, but none of them are to be compared to galls, and are not likely to supersede them in the manufacture of ink so long as galls can be had for a fair price. The cheapest ink is one composed of a saturated solution of logwood obtained by boiling 22 lbs. of logwood in sufficient water to produce, after being strained, 14 gallons of liquor; to this decoction add 1 lb., avoirdupois, of yellow chromate of potash, not bichromate, in solution; the proportions are one thousand parts of solution to one of chromate; the change of colour is not immediate, but it gradually becomes darker. This can be made on a small scale, by using logwood, a quarter of a pound boiled in water to produce two pints, to which, when strained, add 20 grains of chromate of potash in solution.

To prevent Mouldiness in Ink.—Add a few bruised cloves, a little oil of cloves, or a few drops of creosote. If either of the latter is used, first mix with a small quantity of strong vinegar.

Substitute for a Copying Machine.—Write with common writing ink in which lump sugar has been dissolved, in the proportion of 4 scruples, or $1\frac{1}{2}$ dram, of sugar to 1 oz. of ink. Moisten copying paper. Put the paper so moistened upon the writing, and cover with a soft pad of blotting paper, place the whole on the carpet or hearth-rug, one end of which is to be folded over. By treading upon this, an impression will be taken, equal to what would have been taken by a copying machine.

Indestructible Inks.—1. Dissolve 25 grains of powder gum copal in 200 grains of lavender oil, by the aid of a gentle heat; then add $2\frac{1}{2}$ grains of lamp-black, and $\frac{1}{2}$ grain of powdered indigo. 2. In 18 oz. of water, boil shellac, 2 oz., and borax, 1 oz.; when cold, filter and mix with 1 oz. of gum arabic dissolved in 2 oz. of water, to which add powdered indigo and lampblack as much as may be required. 3. Two solutions are necessary.—No. 1 consisting of crystallized chloride of copper, 8·5 parts; chloride of soda, 10·6 parts; and sal ammoniac, 5·3 parts, to be together dissolved in 60 parts of distilled water. No. 2 solution, consisting of 20 parts of hydrochlorate of aniline, to be dissolved in 30 parts of water, to which has to be added 20 parts of a solution of gum made by dissolving 1 part, by weight, of gum in 2 parts of water; and lastly, 10 parts of glycerine. These solutions are kept in separate bottles. When it is required to write anything with the fluids, 1 part, by bulk, of solution No. 1 is mixed with 4 parts, by bulk, of No. 2. The ink must be applied to paper, linen, cotton, wool, or silk, with a quill pen, or small hair brush; at first the writing appears greenish; but it soon becomes black, especially if it is exposed to a higher temperature. 4. 20 grains of sugar dissolved in 30 grains of water, and the addition to the solution of a few drops of concentrated sulphuric acid; the mixture is then heated, when the sugar is carbonized by the action of the acid.

Ink Powder.—1. Mix powdered galls, 4 oz.; powdered sulphate of iron, 1 oz.; powdered gum arabic, 1 oz.; powdered white sugar, $\frac{1}{2}$ oz.; powdered cloves, 1 dram. To these add 1 quart of water, and macerate for an hour or two. 2. Aleppo galls, 3 lbs.; copperas, 1 lb.; gum arabic, $\frac{1}{2}$ lb.; white sugar, $\frac{1}{4}$ lb.; powder and mix. 2 oz. of this powder dissolved in 1 pint boiling water gives a very good ink.

INVISIBLE INKS.—1. Write with dilute nitrate of silver, which, when dry, will be entirely invisible; hold the paper over a vessel containing sulphate of ammonia, and the writing will appear very distinct. The letters will shine with the metallic brilliancy of silver. 2. Write with a solution of muriate of cobalt, and the writing, while dry, will not be perceptible, but if held towards the fire, it will then gradually become visible, and if the muriate of cobalt be made in the usual way, the letters will appear of an elegant green colour. 3. Write with acetate of cobalt previously purified from the iron which it generally contains. When the writing is dry, these letters will be invisible. Warm the paper a little, and the writing will be restored to a beautiful blue. 4. Equal parts sulphate of copper and sal ammoniac dissolved in water. Writing colourless until warmed, then turns yellow. 5. Onion juice, same colour. 6. Solution of chloride, or nitro-muriate of cobalt; writing turns green when heated, but disappears again on cooling. 7. A weak solution of the mixed chlorides of cobalt and nickel. This writing also turns green when heated.

A Cheap Invisible Ink.—Dissolve 1 fluid oz. of common oil of vitriol in a pint of soft water. Stir well and allow it to cool. Write with a clean pen. When dry it will be invisible, held to the fire it turns an indelible black.

COLOURED INKS.—*Red Ink.*—1. Take 4 oz. of ground Brazil wood and 3 pints of vinegar. Boil till reduced to a pint and a half, and add 3 oz. of powdered rock alum. 2. Tincture of red sanders, with a solution of rock alum. 3. Take a ¼ lb. of raspings of Brazil wood, and infuse it 2 or 3 days in vinegar. Boil the infusion for 1 hour over a gentle fire, and filter while hot. Put it again over the fire, and dissolve in it, first, ½ oz. of gum arabic, and then of alum and white sugar ½ oz. 4. Boil 2 oz. Brazil wood in 32 oz. of water, to which add, after the decoction has been strained, ½ oz. of chloride of tin, and 1 dram of powdered gum arabic; then evaporate to 16 fluid oz. 5. Dissolve carmine, 1 dram in ½ dram of strong liquid ammonia, sp. gr. 880, then dissolve 20 grains of powdered gum arabic in 3 oz. of water, which add to the dissolved carmine. 6. Brazil wood, 200 parts; salt of tin, 3; gum, 6; water, 3200. Reduce to one-half by boiling. Filter 7. Brazil wood, 2 parts; alum, ½; cream of tartar, ½; water, 16. Boil down to half, and filter; add ⅛ part of gum. 8. Add to an ammoniacal solution of cochineal a mixture of alum and cream of tartar, till the required tint is obtained. 9. When a very fine colour is desired, digest 1 oz. powdered cochineal in ½ pint hot water; when it is quite cold, add ¼ pint spirit of hartshorn, macerate for a few days, then decant the clear portion. Or dissolve 20 grains pure carmine in 3 fluid ounces of liquid ammonia; add 18 grains powdered gum.

Green-Black Ink.—Take 15 parts bruised gall-nuts, and 200 parts of water, boil for about an hour, strain, and then add to the liquor 5 parts sulphate of iron, 4 parts fine iron shavings, and a solution of ½ pint of powdered indigo in 3 parts of sulphuric acid. This ink writes green, but turns black after a few days; it flows very well from the pen.

Green Ink.—1. Calcine aceto-nitrate of chrome; dilute the green powder with sufficient water. 2. Mix good clear blue and yellow inks in the proportions necessary to give the desired tint. 3. Sap green dissolved in very weak alum water. 4. Verdigris, 2 oz.; cream of tartar, 1 oz.; water, ½ pint; reduce one-half by boiling, and filter.

Blue Ink.—1. Dissolve 2 or 3 oz. of sulphate of indigo in a gallon of water; or by rubbing together 1 oz. of oxalic acid and 2 oz. of fine Prussian blue, to which add 1 quart of boiling water. The excess of iron in the Prussian blue must be first removed by a strong mineral acid, then wash in rain water. 2. Chinese blue, 2 oz.; boiling water, 1 quart; oxalic acid, 1 oz. Dissolve the blue in the water, then add the acid, and it is ready at once.

Purple Ink.—1. Add to a decoction of 12 parts Campeachy wood in 120 parts

of water, 1 part subacetate of copper, 14 parts alum, and 4 parts gum arabic. Let stand for 4 or 5 days. 2. Add a little alum, or chloride of tin, to a strong decoction of logwood.

Violet Ink.—1. Boil 8 oz. of logwood in 3 pints of water till reduced to $1\frac{1}{2}$ pint. Strain, and add $1\frac{1}{2}$ oz. of gum, and $2\frac{1}{2}$ oz. of alum. 2. Cudbear, 1 oz.; pearlash, $1\frac{1}{2}$ oz.; hot water, 1 pint. Allow to stand for 12 hours; strain, and add about 2 oz. gum. If required to keep, add 1 oz. spirits of wine.

MARKING INKS.—1. Twenty-two parts of carbonate of soda are dissolved in 25 parts of distilled water; also 17 parts of crystal nitrate of silver in 24 parts of ammonia; 20 parts of gum are then liquified in 60 parts of water, and mixed with the soda solution; afterwards with the nitrate of silver, and, lastly, 33 parts of sulphate of copper are added. This writes a rich blue. 2. Dissolve 1 dram of nitrate of silver, or lunar caustic, in $\frac{3}{4}$ oz. of water. Add to the solution as much liquid ammonia as will redissolve the precipitated oxide, with sap green to colour it, and gum water to make the volume amount to 1 oz. Marks written with this liquid should be first heated before the fire, and then exposed in the sun to blacken. The linen marked on requires no previous preparation. 3. Damp the linen first with a solution of carbonate of soda. Dry the spot, and write upon it with a solution of the nitrate of silver thickened with gum, and tinted with sap green. 4. Dissolve separately, nitrate of silver, 1 oz.; crystal carbonate of soda, $1\frac{1}{2}$ oz.; mix the solution, and collect the precipitate on a filter; wash well, then introduce the moist precipitate into a mortar, and add 8 scruples of tartaric acid; triturate till effervescence ceases; then add strong liquor ammonia a sufficient quantity to dissolve the tartrate of silver, to which add 4 fluid drams of archil, 4 drams of powdered white sugar, and 12 drams of powdered gum arabic, and make up to 6 fluid ounces, if required, with distilled water.

Crimson Marking Ink is prepared by adding 6 grains of carmine to the liquor ammonia of the above receipt, but it soon loses its crimson colour, and becomes, like other marking inks, a black colour.

INDIAN INK.—Dissolve horn strip with caustic kali root till it is melted. The brown liquid is to be boiled in an iron kettle until it is thick. Then pour on it boiling water, double its weight, and precipitate it with dissolved alum. Dry, grind, and mix it with gum water, and pour it in a mould. A few drops of essence of musk, or of ambergris, may be added as perfume. 2. Horse-beans or the kernels of the stones of apricots. Must be burnt in an oven till perfectly black, ground to a fine powder, and made into a paste with a solution of gum arabic, and then formed into cakes. 3. Mix the finest lampblack with a solution of 100 grains of lac, with 20 grains of borax, and 4 oz. of water. 4. Pure lampblack, mixed with asses' skin glue, and scented with musk.

PRINTING INK.—*Linseed Oil.*—The linseed oil, however long boiled, unless set fire to, cannot be brought into a proper state for forming printing ink; the flame may be most readily extinguished by the application of a pretty tight cover to the top of the boiler, which should never be more than half full. The French prefer nut oil to linseed; but if the latter is old, it is fully as good.

Black Rosin is an important article in the composition of good ink; as by melting it in the oil, when that ingredient is sufficiently boiled and burnt, the two combine, and form a compound approximating to a natural balsam, like that of Canada, which is one of the best varnishes that can be used for printing ink.

Soap.—This is a most important ingredient in printers' ink, for the want of which ink accumulates upon the face of the types, so as completely to clog them up after comparatively few impressions have been taken; it will not wash off without alkaline leys, and it skins over very soon in the pot. Yellow rosin soap is the best for black inks; for those of light and delicate shades,

white curd soap is preferable. Too much soap is apt to render the impression irregular, and to prevent the ink from drying quickly. The proper proportion is when the ink works clean, without clogging the surface of the types.

Lampblack. — The vegetable lampblack, sold in firkins, takes the most varnish, and answers for making the best ink.

Ivory Black is too heavy to be used alone as a pigment for printing ink; but it may be added with advantage by grinding a little of it upon a muller with the lampblack, for certain purposes; for instance, if an engraving on wood is required to be printed so as to produce the best possible effect.

Indigo alone, or with an equal weight of Prussian blue, added in small proportion, takes off the brown tone of certain lampblack inks, or a little Indian red may be ground in with the indigo and Prussian blue, to give a rich tone to the black ink.

Balsam of Capivi, mixed, by a stone and a muller, with a due proportion of soap and pigment, forms an extemporaneous ink, which the printer may employ when he wishes to execute a piece of work in a peculiarly neat manner. Canada balsam does not answer quite so well. After the smoke begins to rise from the boiling oil, a bit of burning paper stuck in the cleft end of a long stick, should be applied to the surface, to set it on fire, as soon as the vapour will burn; and the flame should be allowed to continue, the pot being meanwhile removed from over the fire, or the fire taken from under the pot, till a sample of the varnish, cooled upon a palette knife, draws out into strings of about half an inch long between the fingers. It is necessary to have two kinds of this varnish—a thicker and a thinner, from the greater or less boiling—which are mixed together to suit different purposes; that which answers well in hot weather becomes too thick in cold, and large characters or type do not require such stiff ink as the small. To six quarts of linseed oil thus treated, 6 lbs. of rosin should be gradually added, as soon as the froth of the boiling has subsided. As soon as the rosin is dissolved, $1\frac{3}{4}$ lb. of dry brown soap, of the best quality, cut into slices, is to be introduced cautiously, for its water of combination causes a violent commotion. Both the rosin and soap should be well stirred with the spatula. The pot is to be now set upon the fire, in order to complete the combination of all the constituents. Put next of well-ground indigo and Prussian blue, each $2\frac{1}{2}$ oz. into an earthen pan, sufficiently large to hold all the ink, along with 4 lbs. of the best mineral lampblack, and $3\frac{1}{2}$ lbs. of good vegetable lampblack; then add the warm varnish by slow degrees, carefully stirring, to produce a perfect incorporation of all the ingredients. This mixture is next to be subjected to a mill, or slab and muller, till it is levigated into a smooth uniform paste. 1 lb. of superfine printing ink may be made by the following recipe:—Balsam of capivi, 9 ; lampblack, 3 oz.; indigo and Prussian blue, together, $1\frac{1}{4}$ oz.; Indian red, $\frac{3}{4}$ oz.; yellow turpentine soap, dry, 3 oz. This mixture is to be ground upon a slab, with a muller, to an impalpable smoothness. Red or other coloured printing inks are made from linseed oil, boiled as described above, with the addition of dry pigment of the required colour, which is ground up with the varnish with a stone and muller. The pigments used for coloured printing inks are carmine, lakes, vermilion, red-lead, Indian red, Venetian red, chrome yellow, chrome red or orange, burnt sienna, gall-stone, Roman ochre, yellow ochre, verdigris, blues and yellows mixed for greens, indigo, Prussian blue, Antwerp blue, lustre, umber, sepia, and browns mixed with Venetian red.

Transfer Ink.—For the manufacture of the following inks an iron pot and lid must be procured. Then take as follows:—

Stone Writing Ink.—Virgin wax, 4 parts; tallow, 3; soap, 13; shellac, 6; lampblack, 3.

Transfer Writing Ink.—Virgin wax,

2 parts; white soap, 1; shellac, 1; lampblack, $\frac{1}{8}$.

Chalks.—Virgin wax, 16 parts; tallow, 2; white soap, 12; lampblack, $3\frac{1}{2}$.

Manipulation of Writing Ink and Chalks.—Melt the wax and tallow, and mix with an iron spoon; then add the soap, which must be previously cut into strips, and when melted apply a light, and allow to burn until the whole is decreased to the same bulk as existed before the addition of the soap. The shellac is now to be carefully added, bit by bit, stirring the whole time to effect perfect amalgamation. The black is next to be added, and the whole well mixed while in a liquid state; then poured into a mould, or on a slab, and cut to the required size while warm. The same method of proceeding is alike applicable to the manufacture of transfer writing ink, proceeding with the wax only, there being no tallow.

Re-transfer Inks.—Stone Re-transfer Ink.—Litho. printing ink, 2 parts; writing ink, 2; thin varnish, 2; tallow, $\frac{1}{2}$.

Copper-plate Transfer Ink.—Litho. writing ink, 4 parts; thin varnish, 1; wax, 1; tallow, $\frac{1}{2}$; soap, 1. Carefully melt the ingredients, and when in a liquid state pour into moulds, or cut to the required size.

LITHO. PRINTING INK.—For making litho. printing ink, a copper or iron pot with a lid is provided. In this linseed oil of the best quality is boiled until it will ignite readily upon the application of a light. It is then allowed to burn until the required consistency for the varnish is obtained, which is known by taking a small quantity out with a knife, and permitting it to cool. The lid of the pot is then put on, which extinguishes the flames. It is obvious that this is a somewhat dangerous process to conduct under an ordinary chimney. With this varnish, which must not be too thick, as much best calcined Paris black is ground up as possible. The more black that can be ground in, the richer will the colour be.

Ink — Writing on Lithographic Stones.—Mastic in tears, 8 oz.; shellac, 12 oz.; Venice turpentine, 1 oz. Melt together, add 1 lb. wax, 6 oz. tallow; when they are dissolved add 6 oz. hard tallow soap shavings and mix. Then add 4 oz. lampblack. Mix all well together, let cool slightly, then pour into moulds, and cut into convenient-shaped cakes.

Writing and Drawing on Transfer Paper.—To dissolve solid lithograph ink, warm the pot at the fire or gas, using rain or distilled water to rub it down with, as it is softer than other water. The pen will be found to work better at first if it is dipped in oil, and then wiped previous to writing.

COPPER-PLATE PRINTING INKS.—Take linseed oil 1 pint, put into a dry iron saucepan and boil until it will readily ignite by applying lighted paper; let it burn 10 minutes, now put the lid on and it will cease to burn, add nearly $\frac{1}{2}$ oz. of litharge, and stir well; when cool ready for use mix a little of this oil with lampblack, forming a thick paste; grind this very fine with a muller. The grinding is most important. Boil the oil out of doors.

Black. — Frankfort black, finely ground with boiled linseed oil, or, for very fine work, fat oil.

Red.—Mineral orange red, 5 oz.; Chinese red, 2 oz.

Blue.—Celestial blue, 2 oz.; marine blue, 3 oz.

Green.—Mineral green, 2 oz.; chrome green, 3 oz.

Brown.—Burnt umber, 2 oz.; rose pink, 1 oz.

Lilac.—Prussian blue, 1 oz.; Chinese red, 2 oz.

Pink.—Mineral pink, 2 oz.; satin white, 1 oz.

Orange.—Orange red, 2 oz.; flake white, 1 oz. The above to be ground and mixed with Canada balsam. Or,

Red.—Vermilion.

Yellow.—King's yellow.

Blue.—Smalts.

Green.—King's yellow—green.

Blue.—Prussian blue, and flake white.

Brown.—Burnt umber.

Dark Brown. — Burnt umber and Frankfort black.

Puce. — Frankfort black and vermilion.

Brown.—Frankfort black, and drop lake. These to be ground and mixed with nut or linseed oil.

Gold.—Gold bronze mixed with dark oak and mahogany varnish.

Silver, Copper, Ruby.—The same as for gold, merely substituting the different bronzes. Cards printed in gold, silver, or colours, should, when dry, be placed on a very smooth copper or steel plate, not engraved, and passed through a copper-plate press with rather a tight pressure; this would also improve the appearance of cards printed in like manner with letterpress.

To Clean Copper-plates. — Copper-plates are cleaned by laying them on the hob near the fire, and pouring on them some spirits of tar, and then rubbing them with a small soft brush.

Painting on Vellum.—The illuminated missals, or coats of arms, on vellum may be best done by the above colours, rather than by water colours with gall in them, as is often practised — the colours being applied with a brush as in ordinary painting; also, if more brilliancy is required for gold and silver, those metals may be used in leaf, a coat being first put on with gold size. Gold is best shaded with a bright transparent brown, silver with green.

Ink for Stone, or Marble.—Trinidad asphaltum and oil of turpentine, equal parts. This is used in a melted state for filling in letters cut on tombstones. marble slabs, and monuments, and is very durable.

Writing on Zinc.—1. Mix verdigris, 1 part; sal ammoniac, 1; chimney-black, or any mineral colour, ½; water, 10; stir well or shake the bottle before employing, and use a quill, not a steel, pen, for writing. This ink is a poison. 2. Get a lemon, squeeze the juice out of it into a pot, and put into it an old copper halfpenny or farthing, not the present bronze coin. Let it stand for a day or two. Write with a quill pen. 3. Dissolve 100 grains of chloride of platinum in a pint of water. A little mucilage and lampblack may be added.

Zinc Garden Labels.—For zinc plates use the following, with quill pens only; —1. Dissolve muriate of ammonia and crude sal ammoniac in strong vinegar. 2. For large labels, dip your pen in concentrated sulphuric acid, and write on the zinc, previously greased; a sharp point of copper wire is better than the pen; quench in water; wash thoroughly from fluid when your writing is plain enough. 3. Dissolve about half-a-crown's worth of chloride of platinum in hot distilled water, adding a very few drops of aqua regia. The liquid should be of a pale amber colour. Enough for hundreds of labels.

Gold Ink.—1. Gold, 24 leaves; bronze gold, ½ oz.; spirits of wine, 30 drops; best honey, 30 grains; gum arabic, 4 drams; rain water, 4 oz. Rub the gold with the honey and gum, and having mixed it with the water, add the spirit. 2. Take gold 1 part, nitro-hydrochloric acid 3 parts, mix and evaporate until chlorine in vapour is given off, cool and mix with ether by shaking well together, thicken with naphtha or any essential oil. Gold and silver inks, for illumination, are simply the metals very finely powdered and suspended in weak gum water. Gold leaf ground up with honey, washed and mixed with a thin solution of gum, is excellent for illumination.

Fluxes.—In metallurgical operations the following articles are used as fluxes;—Crude tartar, if on a small scale, commercial cream of tartar, borax, nitre, sal ammoniac, common salt, limestone, glass, and fluor spar. These articles being easy to fuse, are added to substances which are more refractory, to promote their fusion.

Black Flux.—Nitre, 1 part; cream of tartar, 2; mix and burn in small quantities in a red-hot crucible; mix the product with finely-powdered charcoal. Keep in a dry corked bottle. This is used in smelting metallic ores.

Flux for Reducing Arsenic.—Carbonate of soda in crystals, 8 parts; finely-powdered charcoal, 1; heat gradually to a red heat.

Cornish Reducing Flux.—Crude tartar,

10 parts; nitre, 4; borax, 3. Powder together.

Refining Flux.—Crude tartar and nitre equal parts, burnt together.

Crude Flux.—Same as the black flux, omitting the burning in the crucible.

Flux for Arsenical Compounds.—1. Dry carbonate of potassa, 3 parts; cyanide of potassium, 1. 2. Dry carbonate of soda and cyanide of potassium, equal parts.

Morreau's Reducing Flux.—Powdered glass, free from lead, 8 parts; and 1 part each of calcined borax and charcoal. Powder well, and mix together.

Candles.—In its natural state, fat of animals is always associated with cellular tissue and other foreign matters, which must be separated before it can be used as candle stock. In dry melting, the rough suet is cut into coarse pieces and exposed to the action of a moderate heat. By more recent processes the fat is not exposed to heat till it has been subjected to mechanical and chemical appliances, for the purpose of destroying the tissues. The first method possesses the decided advantage, that the residue can be profitably used as food for hogs and fowls. There is also an economy in fuel, and the simplicity of the process commends itself to inexperienced manufacturers. The disadvantages are an obnoxious smell, from the heating of rough tallow which has been collected and suffered to remain till it has become rancid, and the cellular tissues, blood, or other portions advanced towards putrefaction, and the small amount of fat obtained, as portions always remain with the residue when heated in this manner. The fat for tallow ought to be freed from the membranous and muscular parts, then cut into thin slices and hung up in a cool place, not heaped up while yet warm. By operating thus, the disagreeable odour can be delayed for several days.

Tallow Boiling.—First, the fat is chopped; cutting machines are often used similar to the straw-cutting table; sometimes a thin, sharp-edged, mince-hatchet is employed, about 2½ ft. in length. This is held with both hands, and the fat, spread out on a beech block, is chopped into small pieces in all directions. A third instrument is a kind of stamp trough with muller, having a sharp blade in the form of an S, a contrivance frequently adopted for cutting beets. A more desirable instrument, however, is the ordinary rotary sausage-cutter. The fat is then placed in melting caldrons, hemispherical in form, and made of cast iron, which are heated by open fire. These caldrons are covered with movable tin-plate hoods, so adjusted that, by means of pulleys, ropes, and counter-weights, they can be easily raised or lowered, whilst, at the same time, they serve to carry off the offensive vapours arising from the heated fat. Water is sometimes mixed with the fat in the caldrons, and this addition is specially beneficial when the fat has been long kept during the summer months, and has thereby lost it natural moisture by evaporation. By gradually raising the temperature in the pan the fat runs from the cells, and the whole is kept boiling from 1 to 1½ hour. During the whole operation of melting and boiling, the ingredients must be constantly stirred in order to keep the fat and cracklings in incessant agitation, otherwise pieces of unmelted suet, coming in contact with the sides or bottom, would become scorched and acquire a brownish tint, of which the whole melting would necessarily partake. Scorched tallow is not readily whitened. For separating the melted fat from the cracklings, it is ladled off from the caldron into a fine willow basket, or a copper box perforated at the bottom with innumerable small holes, set over large copper coolers, and allowed to remain undisturbed till all foreign matters have settled down. Before it congeals, it should be transferred into small wooden pails. This operation is continued so long as the cracklings yield any fat; and during the process the heat must be maintained at a moderate temperature, to avoid scorching the materials. When the cracklings begin to harden

they acquire a darkish tint, and hence are said to be browning. They are then pressed, and the fat thus obtained possesses somewhat of the brown colour of the cracklings, but not so much as to render it unfit for use as soap stock; it may, consequently, be mixed with that which has spontaneously separated while heating.

New Methods of Rendering.—D'Arcet's Apparatus.—This consists in conducting the rising vapours, consisting chiefly of hydrogen and carbon, through channels under the grate of the rendering pan, and using them as fuel. The pan is also covered with a strong iron plate, the front third of which can be lifted by means of a knuckle whenever it is necessary for stirring, filling, or emptying the kettle. D'Arcet was the first who employed chemicals for the purpose of neutralizing or destroying the noisome effluvia arising from the pans.

To Neutralize Effluvia from Tallow Pans.—Take 50 parts, by weight, of diluted oil of vitriol, put into the kettle, then 1000 parts, in weight, of chopped fat are gradually added in four equal portions; and lastly, 150 parts of water, to which 5 parts, in weight, of sulphuric acid of 66° B. have been previously added. The whole is then heated. Under the influence of the acid, which partly destroys, partly solves the membranes, the rendering of even greater amounts of fat is effected in $1\frac{1}{4}$ to $2\frac{1}{2}$ hours; 2 hours, however, are seldom required. The inventor's proposition of using acids was made when pans were heated by the direct action of the fire; but now steam is more generally employed. This, however, does not prevent the gases arising from the pans being thrown into the furnace and thereby aiding combustion. It is obvious that in the boiler of d'Arcet, stirring, as well as filling or emptying the contents of the pan cannot be accomplished so readily as in an open pan; nor can these processes be performed without opening the covers. To obviate this, a contrivance similar to that used by distillers in the mashing process could be introduced with decided advantage for keeping up the necessary motion, to prevent adhesions to the sides or bottom of the vessel, and consequent scorching.

Wilson's Process.—The chief feature of this process is to steam the rough suet for ten or fifteen hours in a perfectly tight tank, under a pressure of 50 lbs. to the square inch, or more when lard is being rendered. A higher pressure is not profitable, for, though expediting the process, it produces an inferior quality of fat. No chemicals are used. The apparatus consists of an upright cylindrical vessel, made of strong boiler-plates, tightly riveted together. Its diameter is about two and a half times less than its height, and its capacity amounts to 1200 to 1500 gallons. It has a false bottom or diaphragm; below this a pipe enters, which is connected with an ordinary steam-boiler. There is a manhole at the top, through which the vessel is filled with the rough suet or lard to within about $2\frac{1}{2}$ ft. of the top. By a safety-valve the pressure can be regulated. There are also some try-cocks, by which the state of the contents can be examined; if the quantity of condensed steam in the tank be too great, it will be indicated by the ejection of the fatty contents at the top one. There is a regulating cock at the bottom for drawing off the condensed steam, as well as cocks in the side of the digester, by which the fatty materials can be drawn off. Through a hole made in the diaphragm, which can be shut and opened at will, the residual matters can be let out.

Fouche's Process.—Fig. 59 represents a vertical, and Fig. 60 a horizontal section of the apparatus, after the line 1—2 in Fig. 59. Fig. 61 is a transverse section after the line 3—4 in the same figure. The vessel has a copper dome B, fastened by rivets. In this dome is a hole C for introducing fat, having a cover, which may be lifted by a chain going over a pulley, and the margin of the cover may be fastened to the vessel by clamps. This cover has a hole for observing the

Fig. 59

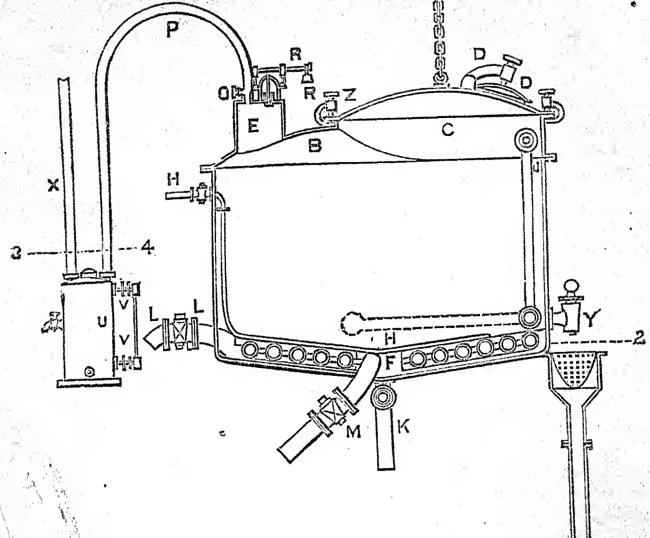


Fig. 60.

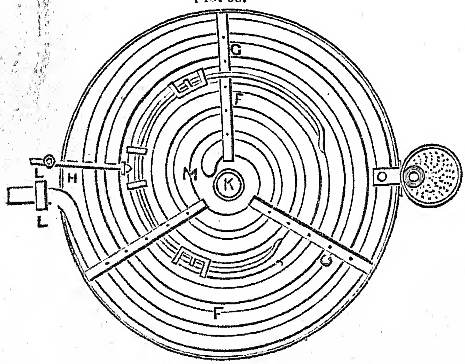
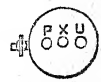


Fig. 61.



inside, which can be shut by a valve fastened to the lever D. E is a cap on the dome with the eduction-pipe for vapours, and P P is a safety-valve, with a counter-weight R. There is, moreover, an outer valve for the passage of air, either when filling or emptying the vessel, as well as a box for a thermometer. The vapours escaping through P, which may be opened by the faucet O, pass into U for the purpose of being condensed there,

or, when not condensed, for escaping through X. F is a worm, which, fastened to the stays G, Fig. 60, lies on the bottom of the vessel. Through L L steam is introduced from a boiler, and through M passes back into the same boiler. H H is a small pipe entering into the vessel A, through which steam also passes into the vessel, mainly for the purpose of keeping the melted fat in agitation. J is a tube, having a sieve at its upper end, and a movable crank below, by which it is fastened to the faucet Y. If the vessel is being emptied; the tube J is gradually let down until its upper part, with the sieve, reaches the bottom. The fat is then passed through J and Y, and through a fine sieve outside the vessel, which acts as a filter. In this, 1000 lbs. are first introduced with 80 lbs. of water; $2\frac{4}{10}$ lbs. of sulphuric acid of 66°, previously mixed with 16 lbs. of water, are then added. Steam is next turned on, which, as described, passes from the generator through the worm, and must have a tension of three atmospheres, or a temperature of 255° F. In the vessel, however, a tension of $1\frac{1}{2}$ atmosphere is sufficient, and when this is reached, the safety-valve is no longer charged with weights. The vapours formed in the vessel are conducted through X into the hearth of the steam-boiler furnace, so that all the noxious odours which, by the action of the sulphuric acid, are diminished, but not destroyed, are thus conveyed from the working rooms.

Evrard's Process.—The apparatus used very much resembles that of Wilson. The process is based on the application of caustic ley, in the proportion of 25 gallons, each containing $\frac{1}{10}$ to $\frac{1}{7}$ lb. of solid caustic soda, to every 250 to 350 lbs. of rough tallow. It is the object of the application of the ley to dissolve the membranous parts, so that no preliminary mincing is necessary. For boiling the fat, steam is employed. As the alkaline ley is heavier than water, it will, after the boiling is completed, more easily subside. It is then drawn off, and the fat left in the tank is again boiled with successive portions of fresh water, for the better separation of which this compound is left for 24 hours in a warm liquid state before being drawn off into the coolers.

Stein's Process.—A mixture of slacked lime and small pieces of fresh-burnt charcoal is prepared, and spread upon a coarse cloth stretched over a hoop, of 2 in. in depth, and the circumference corresponding with the size of the pan. During the process of rendering, it is securely adjusted by suitable catches above the pan. The rising vapours from the latter, in necessarily passing this chemico-mechanical arrangement, are said to be entirely absorbed, so that thus all cause of complaint against tallow factories as health-destroying nuisances would be effectually removed.

Clarifying Tallow.—By mere melting and straining we do not obtain a fat entirely free from admixture of fine, undissolved substances. For separating these substances, it must be clarified, by remelting it in water, either on free fire or by steam. Generally, no more water than 5 per cent. is taken, and stirred well with the fat till the mixture becomes emulsive. The whole is then allowed to rest, without further heating, till the water has separated, when the fat may be drawn off, or dipped off. Sometimes, to conceal the yellowish tint, a very little blue colour is added, consisting of indigo rubbed finely with some oil, of which a few drops are sufficient for large quantities of tallow. The process of clarifying is occasionally repeated. At the line of demarcation between the water and fat, a grey slimy substance is often perceptible, and the liquid itself is turbid. Instead of pure water, some tallow-melters take brine or solutions of alum, saltpetre, chloride of ammonium, or other salts. These agents have no chemical action upon the fats, but simply induce a more rapid settling of the impurities and water, principally when strong agitation is used.

Ozokerit.—This mineral is used in the production of illuminating oils of a

high firing point, and of solid hydrocarbons, more particularly adapted to the manufacture of candles of a high melting point; the inventors distil the raw material by heat, thereby obtaining an oily distillate, the solid and liquid constituent parts of which are then separated by pressure. The pressed solid material is purified by mixing and stirring with sulphuric acid when melted. After standing for some time, in order to effect the complete separation from the acid, the supernatant melted material is carefully decanted off, and thoroughly washed with hot water. The water having been removed, the material is repeatedly filtered through animal charcoal until the requisite degree of whiteness is attained.

Hardening of Tallow by Capaccioni's Process.—In 1000 parts of melted tallow, 7 parts of sugar lead, previously dissolved in water, are stirred, during which process the mass must be constantly agitated. After a few minutes the heat is diminished, and 15 parts of powdered incense, with one part of turpentine added, under constant stirring of the mixture. It is then left warm for several hours, or until the insoluble substances of the incense settle to the bottom. The hardening is produced by the sugar of lead, yielding a material similar to the stearic acid, while the incense is improving its odour; it is said that by this treatment the guttering of the candles is entirely prevented.

Cassgrand's Process for Bleaching Wax.—First melt the wax with steam, which pass together through long pipes, so that a large surface becomes exposed to the steam. After traversing the pipes, it is received into a pan with a double bottom, heated by steam; it is therein treated by water, left quiet for some time until its impurities are settled. It is then forced anew through the pipe together with the steam, washed a second time, and, if necessary, this process is repeated a third time. Probably water is absorbed by the wax, thus rendering it more easily bleached.

Arrangement of a Bleaching-house.—Stakes or posts are driven into the ground, and 2 ft. from the ground bag-clothes are stretched over them, or table-like frames are made from strips of cloth stretched over the frames in the same manner as a sacking-bottom is stretched over a bedstead, care being taken to fasten the ends of the cords to the posts sufficiently firm to prevent them loosening by the wind. This done, the wax ribbons are spread upon the cloth in a thin layer. It is important that the place selected for this process should be so arranged that the sun's rays may have full play upon the exposed wax, but at the same time protected from the prevalent winds. The ribboned wax is daily turned over, in order that fresh portions of it may be affected by the sun; and should it not be sufficiently moistened by the dew or rain, soft water is poured over it. When it is not gradually becoming whiter, but still continues yellow upon the fracture, it is remelted, ribboned, and again bleached. The continuance of the bleaching process varies, depending upon the weather; often one exposure to the sun and air suffices to bleach it, and no remelting is requisite. Four weeks are generally sufficient. The bleached wax is finally fused into cakes or square blocks, previously moistening the moulds. As fast as the wax congeals, the cakes are thrown into a tub of clean, cold water, and then taken out and spread upon a pack-thread sieve for draining. Eventually, they are dried and packed in boxes for the market, the loss being from 2 to 8 per cent.

Wicks.—Wicks are twisted or plaited; the former, loosely twisted, present the appearance of a spiral similar o the separate strands of a rope; the latter, now generally adopted for most kinds of candles, is made by interlacing and crossing the strands of the wicks a the same manner as plaiting straw of bonnets. Common wicks are simply an aggregation of several loosely-twisted threads forming one general cord of many fibres. This is effected by the ball winding machine, a very simple apparatus. For cutting wicks, Sykes's apparatus is in

general use, especially for tallow-candle wicks, which must be soaked with tallow at one end. Fig. 62 represents a vertical, and Fig. 63 a horizontal view of it. *c c*

Fig. 62.

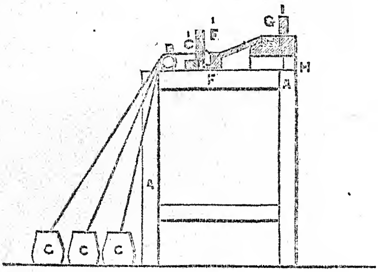


Fig. 63.

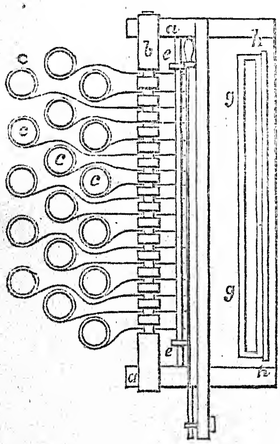
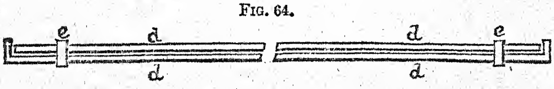


Fig. 64.



are spools on which the wicks are wound. *b* is a roller with grooves cut around it, by means of which the wicks are conveyed into the clamp *d*, represented in Fig. 64 on a larger scale, and as seen from the side. It consists of two wooden frames, which are made tapering from the middle towards the end. On each side there is a feather of steel attached, for the purpose of holding the frames, with a space between them, which may be diminished by sliding the feathered clamps *e e* towards the middle, or increased by drawing them towards the end. Immediately behind the clamp there is a cutting apparatus, consisting of an immovable *f′* and a movable blade *f*, with a handle. *g* is a small vessel filled with liquid fat, which may be kept from solidifying by steam, and a board *i* lying on the lathe *h*. The use of the apparatus is as follows;—The ends of the wicks, wound upon the spools *c c c*, are passed through the frame *d*, properly tightened by the clamps *e e*, so that all the wicks are kept firm. The knife *f* of the cutting apparatus is then lifted out of the way; the frame, with the wicks enclosed, is drawn backwards to the vessel *g*, and the ends of the wicks dipped in the melted fat; this done, the fat-soaked ends are drawn farther back and placed under the weight I, which holds them firmly while the clamps are loosened on the frame, and this returned to its first-described position and again tightened. The knife is next used, cutting all the wicks off at a stroke, then elevated, and the process repeated till a sufficient number of wicks are cut. The thickness of the wicks varies according to the diameter of the candles and the material of which they are made. The number of the cotton threads requisite to form a wick also varies according to their firmness. The yarn is composed of a slack-twisted cotton thread; No. 16 generally for plaited, and smaller, such as 8–12, for common wicks.

Index to the Thickness of Wicks.—The yarn employed is No. 16. For tallow candles, 8 to the lb., the wick

contains 42 threads; 7 to the lb., 45 threads; 6 to the lb., 50 threads; 5 to the lb., 55 threads, 4 to the lb., 60 threads. These wicks, composed of 10, 12, or even 16 cords, are very loosely twisted, and form a kind of hollow tube. For stearic candles, three-corded plaited wicks are generally used, smaller in size and of finer yarn. Stearic candles, 4 to the lb., the wicks consist of 108 threads; 5 to the lb., 96 threads; 6 to the lb., 87 threads; 8 to the lb., 63 threads.

Preparing Wicks.—This is done by wick-mordants, by means of which they are rendered less combustible, especially those for stearic acid, and composite candles. Compounds composed of solutions of ammoniac salts, of bismuth, of borates, or boracic acid, are used. A simple and cheap mordant for wicks is a sal ammoniac solution of 2° to 3° B. This concentration is strong enough, and if a weaker one be used, a spark will remain on the wick after the candle has been blown out, and burning down to the fat, make relighting more difficult. Before moulding is performed, the wicks, having been saturated, are thoroughly dried in a tin box, surrounded by a jacket, in which steam is introduced. Instead of the sal ammoniac, phosphate of ammonia is used in some factories. A very good mordant is also a solution of $2\frac{4}{10}$ oz. boracic acid in 10 lbs. of water, with $\frac{1}{3}$ of an ounce of strong alcohol, and a few drops of sulphuric acid. Some mordants have become unpopular, the fault is in the crude cotton, which does not always readily become moistened; consequently, from not having completely imbibed the mordant, portions of the thread remain unsaturated, and are not equally combustible with the others. An admixture of alcohol will remedy this defect, as cotton is more easily moistened in diluted spirit than in pure water.

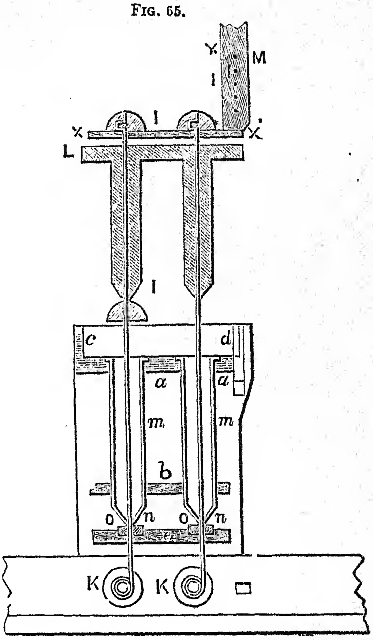
Dips.—These candles are made by stringing a certain number of wicks upon a rod, and dipping them in melted tallow repeatedly. The process is very simple; the clarified and remelted tallow is poured into a tightly-joined walnut or cherry trough, 3 ft. long by 2 ft. wide, and 10 to 12 in. wide at the top, gradually diminishing to 3 or 4 in. at the bottom. A handle is fixed on each end for its easy removal, and when not in use it is closed with a cover. The operator commences by stringing 16 to 18 wicks at equal intervals on a thin wooden rod, about $2\frac{1}{2}$ ft. long, and sharpened at the ends. He then takes 10 or 12 such rods and dips the wicks rapidly into the fluid tallow in a vertical direction. This tallow should be very liquid, in order that the wicks be soaked as uniformly as possible, after which the several rods are rested on the ledges of the trough, when, if any of the wicks be matted together, they are separated, and the rods so placed on a frame, having several cross-pieces, that the uncongealed tallow from the wicks may drop down, and while this is going on, which continues till the tallow is cooled and solidified, the operator is engaged in preparing another batch of rods. The fat in the trough, meanwhile, is so far cooled that in immersing the first dip again a thicker layer will adhere to the wicks. It is considered, that when the tallow solidifies at the sides of the vessel, the temperature is the most convenient for the object in view. It is sometimes necessary to stir the ingredients to produce a uniform admixture, and in such cases much care should be taken so that no settlings be mingled with the mass, whilst by the addition of hot tallow any desired temperature may be obtained. The tallow on the wicks between each dipping becomes so gradually hardened, that at the third or fourth immersion new layers necessarily solidify; as a natural consequence of the method of dipping, the lower ends of the wicks become thicker than the upper, to remedy which the lower ends are again put into the melted fat for a few minutes, when the heat, as a matter of course, diminishes their dimensions. The process of dipping is continued until the candles acquire the requisite thickness. The conical spire at the upper end is formed by immersing

deeper at the last dip, and if, eventually, the candles are too thick at the lower end, they are held over a slightly-heated folded copper sheet, so that the fat may melt, but not be wasted.

Moulds.—For moulding, besides the common metal moulds, a mixture of tin and lead, moulds of glass are sometimes used. The former are slightly tapering tubes, varing in length and dimensions according to the size of the candle to be manufactured, and, when required, are arranged in regularly-perforated wooden frames or stands, with the smaller end downwards, forming the upper or pointed part of the candle. At this smaller end, the wick, previously saturated in melted fat, is inserted, filling the aperture, and, passing up the centre, is fastened perpendicularly at the upper end of the tube, to which is attached a movable cover. The melted fat is then poured in, generally with a small can, but a tinned iron siphon is better. It is requisite that the tallow should completely fill the mould, that it should remain uncracked on cooling, and should be easily removable from the moulds. This can, however, only be obtained when the fat at the sides cools more quickly than that in the interior, and when the whole candle is rapidly cooled. A cool season is, for this reason, far better; but a certain condition of the tallow, namely, that which it possesses at a temperature very near its melting point, is absolutely necessary. Candle-makers recognize the proper consistence of the tallow for moulding by the appearance of a scum upon the surface, which forms in hot weather between 111° and 119° Fahr., in mild weather at 108°, and in cold about 104°. The tallow is usually melted by itself, sometimes, however, over a solution of alum. The candles are most easily removed from the mould the day after casting, to be cut and trimmed at the base. Moulding by hand is a very tedious operation, and only practised in the smaller factories; in more extensive establishments, where economy of time and labour is a consideration, machinery is employed.

Kendall's Moulding Apparatus.—Fig. 65 represents a vertical transverse sec-

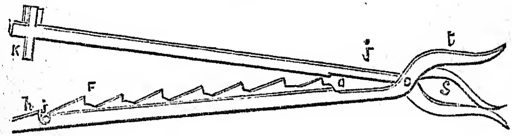
FIG. 65.



tion through one of the mould-frames, exhibiting the candles drawn from the moulds. Fig. 66 represents a top view of a row of moulds, showing the clamp in place ready to centre the wicks. The moulds are mounted upon cars, for being carried from place to place as required, each capable of conveying several dozens, which are heated to about the temperature of the melted fat by running the car into an oven. The moulds thus heated are carried by cars to a caldron containing the melted fat, with which they are filled. The car is then attached to one of the empty trucks and allowed to remain till the candles are cooled, when it is moved to an apparatus, by means of which the candles are drawn

and the moulds re-wicked, and again ready to be heated and filled. In Fig. 65, *m m* represents moulds mounted on two horizontal boards *a* and *b*, in which round holes are cut, and tightly screwed at the upper end, around which a thin wooden frame is attached, $\frac{3}{4}$ of which is firmly fastened, whilst the other $\frac{1}{4}$ forms a slide. The lower end of the moulds rests on pieces of vulcanized india-rubber *o*, let into the cross-bar *e*; each piece of india-rubber being pierced with a hole somewhat smaller than the wick, and as the wick is passed through this hole, the latter compresses it so tightly as to prevent the fat from leaking out. In like manner, the leakage is prevented between the bottom or tip *n* by the pressure of the mould upon the india-rubber. The spools K hold the wicks firmly and centrically secured by clamps. On the ledge *c* of the bottom *a* there are four pins *i*, which tighten the clamps *j*, Fig. 66, by means of small holes *g h*. On one side F of the clamp there are also toothed jaws, in which the wicks fit exactly, that is, they are thus kept vertical and in the centre of the moulds. The construction of the clamp, Fig. 66, is such that the arm working upon a joint at *o*, and being brought against the arm F, falls into a groove made in its length, so as to press and kink the wicks in the groove, and fasten them firmly there by means of the spring catch K. The object of this is, that in raising the candles from the moulds by this clamp they shall not slip nor move. As the candles are lifted out of the moulds, as in Fig. 65, the wicks are drawn after them from the spools K, and are then clamped in position in the manner described. The wicks are next cut off above the lower clamp, the candles with the clamps removed, when, by sliding off the spring catch K, the spring S, between the jaws *t t*, causes the arm *j* F to separate and release the wicks.

FIG. 66.



Composite Candles.—Melt together, over a water bath, 100 parts of stearic acid, and 10 to 11 parts of bleached beeswax; but, to ensure success, the mixture must remain over the bath from 20 to 30 minutes, without being stirred or agitated. At the end of that time the fire is to be extinguished, and the fluid allowed to cool until a slight pellicle is formed on the surface, when it is cast direct into the moulds, previously heated to the same temperature, with the precaution of avoiding stirring the mixture, which would cause opaqueness.

Transparent Bougie.—For 100 lbs. of stock take 90 lbs. of spermaceti, 5 lbs. purified suet of mutton, and 5 lbs. wax; melt each separately over a water bath, and to the whole, when mixed together, add 2 oz. of alum and 2 oz. of bitartrate of potassa in fine powder; and, while stirring constantly, raise the heat to 176° Fahr.; then withdraw the fire and allow the mixture to cool to the temperature of 140° Fahr. When the impurities subside, the clear liquid must be drawn off into clean pans. For quality and good appearance, candles made of this cooled block are more than proportional to its cost. Substitute plaited wicks for the foregoing mixture to the wicks generally used for composite candles, and prepare them by previously soaking in a solution of 4 oz. borax, 1 oz. chlorate of potassa, 1 oz. nitrate of potassa, and 1 oz. sal ammoniac,

in 3 quarts of water. After being thoroughly dried, they are ready for moulding.

Diaphane.—It is made by melting together, in a steam-jacket, from $2\frac{1}{2}$ to $17\frac{1}{2}$ lbs. of vegetable wax, $1\frac{1}{2}$ to $10\frac{1}{2}$ of pressed mutton tallow, and 22 to 46 lbs. of stearic acid. Both the latter and the vegetable wax are the hardening ingredients. By changing the proportions between the above limits, a more or less consistent mixture may be formed. The moulding is performed in the same manner as for stearic-acid candles.

Parlour Bougies.—1. Melt slowly, over a moderate fire, in a well-tinned copper kettle, 70 lbs. of pure spermaceti, and to it add piecemeal, and during constant stirring, 30 lbs. of best white wax. By increasing the proportion of wax to 50 lbs., the resulting product is much more diaphanous; however, the bougies moulded of this mixture are not as durable as candles made exclusively of wax. They are tinted in different colours. For red, carmine or Brazil wood, together with alum, are used. Yellow is given with gamboge, blue with indigo, and green with a mixture of yellow and blue. Sometimes the bougies are perfumed with essences, so that in burning they may give off an agreeable odour. 2. Add $6\frac{1}{2}$ lbs. of wax to 100 lbs. of pure dry sperm, candles made from this mixture very much resemble Judd's Patent Candles.

Composite Candles.—The block for these candles is made by adding a portion of hot-pressed cocoa stearine to stearic acid of tallow. This is a good and economical mixture.

Belmont Sperm is a mixed stock of hot-pressed stearic acid from palm and cocoa butters.

Belmont Wax is palmitic acid coloured by gamboge.

Candles with Snuffless Wicks.—The great objection to tallow candles is the frequent necessity for removing the snuff, or charred wick, which rises into the body of the flame and obscures the light. If the wick can be exposed to the air it will be entirely consumed. 1. This is done in composite candles by plaiting the cotton into a flat wick, which as it burns curves over. Sometimes a very fine wire is included in the wick, which is usually dipped in a solution of borax. 2. Twist the wick with one strand shorter than the others, which will bend the wick slightly when the fat melts.

Fire Lute.—1. Mix thoroughly 2 parts good clay, 8 parts sharp washed sand, 1 part horse-dung, then temper like mortar. 2. Linseed or almond meal mixed to a paste with milk, lime-water, or starch-paste. This lute stands to 500°.

Fat Lute.—1. Mix dry clay in powder with drying oil into a thick paste. The part to which this is applied must be clean and dry. 2. Plaster of Paris mixed with water, milk, or weak glue. Both these lutes stand a dull red heat.

Rust.—*To prevent Rusting.*—1. Boiled linseed oil will keep polished tools from rusting if it is allowed to dry on them. Common sperm oil will prevent them from rusting for a short period. A coat of copal varnish is frequently applied to polished tools exposed to the weather. Woollen materials are the best for wrappers for metals. 2. Iron and steel goods of all descriptions are kept free from rust by the following;—Dissolve $\frac{1}{2}$ oz. of camphor in 1 lb. of hog's lard, take off the scum, and mix as much black-lead as will give the mixture an iron colour. Iron and steel and machinery of all kinds, rubbed over with this mixture, and left with it on fo 24 hours, and then rubbed with a linen cloth, will keep clean for months. If the machinery is for exportation it should be kept thickly coated with this during the voyage.

Anti-rust Varnish.—Take the first three ingredients in a pounded condition, and digest them by a regular heat till melted, then add the turpentine very gradually, stirring all the while. Rosin, 120 parts; sandarac, 180; gum lac, 60; essence of turpentine, 120. The mixture should be digested until dissolution, then add rectified alcohol, 180 parts. Filter through fine cloth or

thick bibulous papers, and preserve in well-stoppered bottles or cases.

Extracting Rust from Steel.—Immerse the article to be cleaned for a few minutes until all dirt and rust is taken off, in a strong solution of cyanide of potassium, say about ½ oz. in a wine-glassful of water; take out and clean it with a toothbrush, with some paste composed of cyanide of potassium, Castile soap, whitening, and water; these last are mixed in a paste about the consistence of thick cream.

India-rubber. — *Solvents.* — Benzine is an excellent solvent for caoutchouc and gutta-percha. Caoutchouc, or india-rubber, may also be dissolved in ether, sulphide of carbon, naphtha, or spirit of turpentine, and in chloroform.

India-rubber Solution.—1. A mixture of 6 parts absolute alcohol with 100 of sulphate of carbon; the latter is the real solvent, the alcohol has an indirect action. The quantity of solvent required depends on the consistency of solution required; if moderate heat is used, and the mixture shaken, the whole dissolves, but a better solution is obtained for adhesive properties by using a large quantity of solvent, not shaking, but drawing off the clear glazy liquid. 2. For a small quantity, place 1 fluid dram sulphuric acid and the same quantity of water into a phial bottle, and well shake together. Great heat is evolved. Allow to stand till cool; then add 2 fluid oz. of spirits of turpentine, and shake well. Great heat will again be evolved, and the colour changed to deep cinnamon. Allow to stand for 24 hours, after which a strong dark sediment will have settled at the bottom of the bottle. Pour off the clear liquor into another bottle, and add 1½ dram apothecaries' weight of common india-rubber cut up into fine shreds, and then place it uncorked over a very gentle heat, and allow to boil slowly for 5 hours. At the end of that time the india-rubber should be perfectly dissolved. It can be concentrated by longer boiling, or thinned by the addition of more turpentine.

Piecing India-rubber.—Make a long bevel on the ends to be joined with a sharp rough-edged knife and water, scrape the bevels rough with the edge of the knife, and when quite dry, give each a coat of india-rubber solution. Say 1 oz. of rubber not vulcanized to 5 oz. of turpentine. When the first coat is dry, give it another, and when that is dry, put the two ends together.

EBONITE AND VULCANITE.—The only difference between these two articles is in the colouring materials used. These terms are applied to a compound of india-rubber and sulphur, exactly the same as the common elastic bands, the only difference being in the time and heat required to vulcanize or harden the compound. To prepare it as sold in the form of combs, the india-rubber is put into a masticator along with a proper proportion of sulphur, and when thoroughly mixed a sufficient quantity is put into a mould of the right shape made of plaster of Paris, or other material which will not combine with sulphur, and exposed in a steam boiler to a heat of 315°, and a pressure of about 12 lbs. to the inch for 2 hours. It is then removed from the mould, and finished, and polished exactly in the same manner as ivory. The application of heat as above without a steam pressure is sufficient to vulcanize or harden the compound, but the result is not always so satisfactory, as the material is liable to be porous if not compressed whilst hardening. Gutta-percha may be treated in exactly the same manner as india-rubber, and cannot be distinguished from it, but is rather more troublesome to work. The vulcanite may be turned or carved in the same way as ivory, with the advantage that it may be moulded to the required form without the great waste which attends ivory carving. It is also much less liable to fracture. The smaller the proportions of sulphur in the rubber, and the lower the temperature used, the softer and more elastic will be the india-rubber. About 10 or 15 per cent. of sulphur, and a temperature of 270° or 275° for 4 hours, will make an elastic rubber; 30 per cent. of sulphur and a

temperature of 315° for two hours will make a hard vulcanite-like ivory.

Welding Cast Steel.—1. Heat the steel carefully, watching it, in a gentle fire kept free from dirt, and use the following composition;—Ten parts of borax and 1 of sal ammoniac; grind them together roughly, and then fuse them in a metal pot over a clear fire, taking care to continue the heat until all spume has disappeared from the surface. When the liquid appears clear the composition is ready to be poured out to cool and concrete, afterwards to be ground to a fine powder. This may be best done by running it into a strong iron vessel, or, if in a smith's shop, into a hole in the swage; put in a piston, and use the sledge-hammer. A small quantity of this composition will be sufficient sprinkled on the parts to be welded while in the fire. Care should be exercised in hammering the splice. To use this composition, the steel to be welded is raised to a heat which may be expressed by bright yellow; it is then dipped into the welding powder, and again placed in the fire until it attains the same degree of heat as before, it is then ready to be placed under the hammer. 2. Borax, 10 parts; sal ammoniac, 2; flour of sulphur, 1; grind or pound them roughly together; fuse them in a metal pot over a clear fire, taking care to continue the heat until all scum has disappeared from the surface. Use in the same manner as No. 1.

Lead Burning.—The apparatus required is a cast-iron furnace, two or three ladles, and some moulding sand. Burning is resorted to by plumbers generally for purposes where soldering will not stand, such as retorts used in bleaching works where the acid destroys soldering. Cast a sheet of lead of the proper thickness, and cut the proper length and width, turn it up round like a hoop, bringing the two ends well together to form a good joint on the outside, and firmly tack them together on the inside; roll it over to see that the joint is close on the outside, and paste a piece of stout brown paper about 4 inches wide over the whole length of the joint. The sand must be well tempered not to have any wet lumps in it; make a level bed with the sand about 5 or 6 inches thick; roll the hoop on the sand so that the joint will come under, be careful not to shift it backwards or forwards, but well ram up under both sides. Have a strip of wood rather longer than the joint, about $\frac{3}{4}$ inch thick, to form the runner with, place it along on edge on the top of the joint; now place some sand both sides and well ram it together, adding sand until there is a good bank on the top of the work; smooth it off with a trowel, cut it down towards the strip, so as to form a sort of funnel, leaving about 2 inches of the strip buried; draw out the strip endways, be careful not to break the sand, leaving one end stopped up, the other end stop up about 1 in. high. At this end make a bay or pond for the overflow metal to run into. Have the metal red hot, be careful that the runner is free from loose sand, shake a little pounded rosin along in the runner, have a trying stick that can be drawn easily along the runner. Now begin to pour the metal, of which have plenty, holding the ladle at least 1 ft. above the runner so as to give weight and force to the burning metal; pour plenty, not minding what is running off, as the metal that is pouring in has to melt the part which is in the cold sand. When the joint is burnt through try it by drawing the trying stick along in the runner; if it feels smooth along the bottom it is burned, if not pour some more until it is, then stop up the end where the metal has been running off, and fill up about 2 inches high, and watch for shrinkage, having some hot metal ready to fill up as it shrinks down in cooling, or else the joint will not be round. When set remove it from the sand, and cut off the runner with a mallet and chisel, finishing off with a piece of cardwire, the paper on the outside will strip off, leaving it clean, whereas if the paper was not used the sand would adhere to the metal, which would look bad. Having now completed this part and set it up, round in shape, proceed with burning in the bottom;

having a hole or pit in the floor deep enough for the hoop to go down level with the floor, place it in perfectly level. Having placed the hoop level, fill up with sand inside and out rather slack. When filled up within about 4 or 5 inches from the top, ram it down for the other part quite hard on the outside, leaving the sand rather higher than the edge; then with a straight-edge scrape off level with the edge of the lead. Now with a scribe take out the sand the thickness of the required bottom, plane the sand off with a trowel, and the work will turn out clean. The sand on the outside being up level with the edge, smooth off, and cut a bay all round to take the overflow, shake a little pounded rosin round the edge; having the metal red hot, begin to pour as before, only this is a work for two or three persons if it is any size, as it must be done quickly, pouring the hot metal along the edge until it is properly burned down; when it is burned deep enough, pour a few ladlefuls all over the bottom, so as to get it in a thoroughly fluid state; then with the edge of the trowel clean off the dross, leaving a perfectly bright surface; let it remain to set. This will not require any filling up, as it is open to the air and shrinks; when set it may be removed, and if well burned it will be perfectly solid.

Whalebone.—Whalebone is the substitute for teeth in the Greenland whale, and in the black southern whale; The surface of the blade is compact, and susceptible of a high polish by mere friction. Its texture is lamellar in the direction of its breadth, so that it easily splits and divides in this direction, but not in that of the thickness of the blade; the middle of the blade is of a looser texture than the rest, and is called the grain, being composed of coarse, bristly hairs. The general colour of whalebone is a dusky greyish black, intermixed with thin strips or layers of a paler colour, which are often almost white—very rarely the entire flake is milk-white. To prepare the whalebone for use, it is boiled in water for several hours, by which it becomes soft enough to be cut up, while hot, in lengths, according to the use to which it is to be applied; or, by means of a compound guarded knife, is cut into fibres for brushes, which are extensively used in stables for the first process in cleaning a horse. Whalebone that has been boiled, and has become cold again, is harder and of a deeper colour than at first; but the jet-black whalebone has been dyed. The principal consumption of whalebone is for stretchers to umbrellas and parasols, also for women's stays, and whips are made of plaited whalebone. White whalebone has been made into bonnets, and likewise into artificial flowers, as its texture is well adapted to this purpose; and it will, by the usual dyeing processes, take very bright and durable colours.

Silk.—*Solvents.*—Several substances dissolve silk, such as the ammoniacal solution of oxide of nickel; that of copper dissolves cotton as well as silk, the silk is precipitated by acids. Chloride of zinc saturated with zinc oxide also dissolves silk, but in no case can silk thread be dissolved without the thread being decomposed.

To Renovate Silk.—Potato-water is good to clean all colours and kinds; grate the potatoes into cold spring water, say a large potato to every quart of water, of which five or six will do for a couple of dresses. If for very light silk, pare the potatoes; if for dark, merely wash them clean. The pan of water must not be stirred in the least for 48 hours; then, very slowly and steadily pour off the clear liquor, but not a particle of the sediment, into a large open vessel, dip the pieces of silk into this liquid up and down a few times, without creasing them; then wipe them on a flat table with a clean towel, first one side, then the other. It is as well to hang each one as dipped upon a line to allow the drops to drain off a little before wiping. Have a damp cloth to cover them in till all is done; then iron one way, on the soiled side.

Freezing.—In the production of

ice, or an extreme degree of cold, by saline mixtures, the salts should be in crystals, and as rich as possible in water, but not in the least damp. Coarsely pulverize when about to use them, and do not mix until just before throwing them in the liquid ingredients. The mixture should be made in a thick vessel, well covered with non-conducting material, to prevent the access of external heat; the substance to be frozen must be contained in a very thin vessel, so as to expose it more fully to the action of the mixture. Thus the ices used in confectionery are made by placing the cream, or sweetened water, in a tin, which is immersed in a bucket containing a mixture of powdered ice and half its weight of common salt—move the tin about in the freezing mixture until the cream has sufficiently solidified.

Freezing Mixtures. — 1. Snow or pounded ice, 2 parts; chloride of sodium, 1. 2. Snow or pounded ice, 5 parts; chloride of sodium, 2; sal ammoniac, 1. 3. Snow or pounded ice, 12 parts; chloride of sodium and nitrate of ammonia, 5 of each. 4. Snow, 8 parts, concentrated hydrochloric acid, 5.

Freezing Powders.—1. 4 lbs. of sulphate of soda, 2½ lbs. each of muriate of ammonia and nitrate of potash; when about to use add double the weight of all the ingredients of water. 2. Equal parts of muriate of ammonia and nitrate of potash; when required for use add more than double the weight of water. 3. Nitrate of ammonia and water in equal proportions. 4. Carbonate of soda and nitrate of ammonia equal parts, and one equivalent of water.

Carré's Ice-making Machine.—It consists of an upright boiler partly filled with very strong ammoniacal solution, so strong that a glass bottle of it held in the hand at once gives off bubbles or gas. From the top of this rises a tube to about the same height as the boiler. This tube ends in a smaller one, which bends down to level of top of the boiler, and is inserted into a cylindrical vessel kept at a distance of about a foot and a half from the boiler. This cylinder has a smaller one riveted into it, in which the tin containing the water to be frozen is to be inserted. The whole of the machine is hermetically closed, so as to allow no escape of the gas. The boiler is put on a charcoal fire, and when a thermometer shows the temperature to have risen to the proper point the solution is converted into gas at a great pressure. The boiler is removed from the fire, and placed in a tub of cold water; the tin of liquid to be frozen is placed in the cylinder, and the gas begins to condense. In a certain time, according to the coolness of the water in the tub, such a great degree of cold is produced by the condensation that the contents of the tin are frozen solid. In hot countries the water in the tub must be changed two or three times as it gets warm. Instead of water, cream, or bottles of beer or wine may be placed in the cylinder. The wine, not requiring to be frozen, may remain only a short time, and then be replaced by a second or third edition, till the gas is completely condensed. The solution lasts many years. The boiler can be filled again, but it is a very troublesome operation, as the moment a soldering iron is brought near the aperture, the gas begins to escape; still it has been done.

To Preserve Ice.—1. Put the ice on a dish and cover it with a napkin, then set the dish upon a feather bed or pillow, and place another bed or pillow on the top of it. In this way a few pounds of ice may be kept for a week or more. 2. Wrap the ice in a piece of old flannel, and if not required immediately bury it in the ground.

Ice House.—If possible, choose for the site of an ice house the north-east side of a hill or plantation, or the inside of a plantation where it would be perfectly shaded with trees; then have the earth excavated to the required size, and, in addition, sufficient to allow of a double wall being built with from 6 in. to 1 ft. space between each wall. The shape may be either an inverted cone or a square; whichever form is used, there

must be perfect drainage insured from the bottom of the well, so that the ice will be kept dry. It can be arched over at top and covered with earth, or roofed with timber and well thatched with straw. The entrance should be by double doors, with the space between filled with straw; the inner door should be perfectly air-tight. In storing see that the ice is well smashed and pounded into the well, as upon this will depend a great deal its keeping properties.

Solders.—*Solder for Jewellers.*—Melt together in a crucible 19 parts fine silver; copper, 1 part; and brass, 10 parts.

Silver Solder for Plating.—Melt together 10 dwts. of brass, and 1 oz. of pure silver.

Gold Solder.—Melt together pure gold, 12 parts; pure silver, 2 parts; and copper, 4 parts. Fuse together 3 parts gold, 2 parts silver, $1\frac{1}{2}$ copper, then add $\frac{1}{2}$ part zinc, for a solder that will flow at a dull red heat, suitable for gold brooches, guards, &c.

Hard Solders.—1. 2 parts of good silver and 1 of ordinary brass pins, well melted, is a good, useful, jewellers' hard solder; but it must not be melted more than once. 2. Hard silver solder composed of 4 parts of fine silver and 1 of copper, made into an alloy and rolled into sheets, is very difficult of fusion. These alloys are run into convenient bars or strips for use. Silver solders are used for soldering silver-work, gold, steel, and gun-metal. A neater seam is produced with the hard silver solders than with soft solders.

Soldering Jewellery.—1. Jewellers solder with gold of a lower title than the article to be soldered—borax, flux, and blowpipe, enveloping the other part with tissue-paper and whitening. 2. Gilding by simple immersion, 1 dwt. fine gold, very small; put into a saucer, add $\frac{1}{2}$ oz. muriatic acid, $\frac{1}{4}$ oz. nitric acid; keep the saucer over a slow fire till the gold is dissolved, move the saucer till the acid evaporates and leaves the gold dry in dark red crystals around the saucer; then add 1 oz. cyanide of potassium, dissolve in $\frac{3}{4}$ pint of boiling water; pour this over the crystals in the saucer to wash them off, let it all run into a basin, stir, and it is fit for use; lay the object to be gilt on a small bit of clean zinc. Put in bath, remove in a minute, scratch-brush, immerse again for a minute, scratch-brush, wash in boiling water, dry out with boxwood dust.

SOLDERING SILVER.—*Solder.*—Fine silver, 2 parts; brass wire, 1 part; melt the silver first in a crucible, when it is melted put the brass wire in the crucible, it will soon melt and mix with the silver; put a little borax with it, and give it a good heat for about 10 minutes, then pour it in the skillet and pass it through the flattening mills until it becomes the thickness of a threepenny piece, when it is ready for use.

Solders of various Hardness.—1. Hardest; silver, 4 parts; copper, 1 part; fuse together. 2. Hard; sterling silver, 3 parts; melt, add brass wire, 1 part. 3. Soft; silver, 2 parts, melt; add brass wire, 1 part, this is generally used; some add a little arsenic, to make it whiter and more fusible, but it becomes less malleable and more injurious. 4. Pure tin, or tin solder, 2 parts lead to 1 part tin, used for inferior work. 5. Fine brass, 6 parts; silver, 5; zinc, 2.

Soldering German Silver.—Clean the places where you want the solder to run by scraping, then paint it with spirits of salts, to which add, before using, a small piece of zinc; put a piece of pewter solder on, and direct the flame of the gas or lamp on the article. The solder will run into the places which have been touched by the spirits of salts.

Solder.—5 parts German silver, 4 parts zinc. Melt, run into thin cakes, and powder.

Silver Solder for Plated Metal.—Melt together 10 dwts. of brass and 1 oz. of pure silver.

Best Soft Solder for Cast Britannia Ware.—Tin, 8 lbs.; lead, 5 lbs.

White Solder for Silver.—Silver, 1 oz. tin, 1 oz.

Pewter and Britannia Metal.—10 parts tin, 5 parts lead, bismuth, 1 to 3 parts.

Soldering Zinc.—The parts to be

soldered must be well cleaned and bright; tin the copper soldering iron by rubbing it while hot in dry hydrochlorate of ammonia with a globule of solder. First wet the parts to be soldered with a solution of chloride of zinc. For zinc plates use the acid alone; next apply the solder, rubbing it with the iron till it unites with the metal. The solder for zinc is composed of 2 parts tin and 1 of lead.

Solder for Tin Plates.—Tin, 2 parts; lead, 1 part. Add 1 part bismuth if desired to use for pewter.

Soft Solders.—*Soft Gold Solder* is composed of 4 parts gold, 1 of silver, and 1 of copper. It can be made softer by adding brass, but the solder becomes more liable to oxidize.

Soft Silver Solder.—A strong, easy-flowing and white solder for jewellers' use is composed of lead, 1 part; and tin, 2 parts. When the lead is melted put in the tin, and then throw in a small piece of rosin as a flux. In soldering fine work wet the parts to be joined with muriatic acid in which as much zinc has been dissolved as the acid will take up. It is cleaner than the old method of using Venice turpentine or rosin.

Soft Soldering Copper, or Pewter.—Copper, pewter, tin, lead, and brass, can be soldered with spirits of salts, which has been killed with zinc, for a flux. This will solder anything but zinc itself, for which free acid must be used. The killed spirits may remain open to the air for weeks without deterioration.

Plumbers' Soft Solder is composed of tin and lead in equal parts.

Hard Solder.—Copper, 2 parts; zinc, 1 part.

Chemical Soldering.—A neat mode of soldering for small articles;—Cut a piece of tin-foil the size of the surfaces to be soldered; dip a feather in a solution of sal ammoniac, and paint over the surfaces of the metal; then place them in their proper position, with the tin-foil between; put it so arranged on a piece of iron hot enough to melt the foil; when cold they will be found firmly fastened together.

Solder for Steel Joints.—Take 19 dwts. of fine silver, 1 ditto of copper, 2 ditto of brass; melt under a coat of charcoal dust. This solder possesses several advantages over the usual spelter solder or brass, as it fuses with less heat, and has a better appearance than brass.

Soldering without Heat.—Take 1 oz. of ammoniac and 1 of common salt, an equal quantity of calcined tartar, and 3 oz. of antimony. Pound well together and sift. Put this in a piece of linen, and enclose it well round with fullers' earth about an inch thick; let it dry, then put it in one crucible covered by another crucible, over a slow fire, to get hot by degrees. Keep up the fire until the contents of the crucible get red hot and melt. Then let it cool gradually, and, when cold, pound the mixture. When you wish to solder anything, put the two pieces you want to join together on a table close to one another. Make a crust of fullers' earth, so that, passing under the joint and holding to each piece, it shall be open at the top. Then throw some of the powder between and over the joint. Dissolve some borax in some hot wine, and with a feather dipped in the solution rub the powder at the place of joint. It will immediately boil up. As soon as the boiling stops the consolidation is made. The calcined tartar is made by placing crude tartar in a covered crucible, and raising it to a low red heat. Allow it to cool gradually.

Chloride of Zinc Soldering Fluid.—1. Muriatic acid with zinc dissolved in it till it will take no more. 2. Dissolve zinc in hydrochloric acid until the acid will dissolve no more.

Solder for Tinware.—The lining of tea-chests makes a good solder for tinware, being made of tin and lead in about the proper proportions.

To Braze Steel and Iron without Heat.—Take ¼ oz. fluoric acid, 2 oz. of brass filings, and 1 oz. of steel filings. Put them all into the fluoric acid; touch each part of the work with the mixture, and put them together. Take care that the fluoric acid is put into an earthern vessel.

Soldering Iron and Lead Pipes.—File the end of the iron pipe bright, then see that the soldering iron—which should be as large a one as can be got—is well tinned; this is important in all soldering operations. Having the iron ready, and as hot as it will bear, wet the part to be tinned with a little spirits of salt that has had as much zinc chippings put in it as it will dissolve, then apply the solder with the iron; the pipe will have to be very hot with the iron before it will tin; it would be as well to tin the iron pipe with a little block tin or pewter, if available. If any difficulty is found in tinning the iron pipe, a little powdered sal ammoniac can be sprinkled over it when very hot, which would assist the tinning; this done, the lead pipe must be widened out so as to form a lip all round the iron pipe, and soldered round with fine solder, taking care to keep the heat of the iron on the iron pipe rather than the lead; or a plumber's joint may be made by pouring on a quantity of plumbers' solder from a ladle, and wiping off the superfluous solder with a greased cloth.

Brass Solder for Iron.—The plates of brass are to be melted between the pieces that are to be joined. If the work be very fine, as when two leaves of a broken saw are to be brazed together, cover it with pulverized borax, melted with water, that it may incorporate with the brass powder which is added to it; the piece must then be exposed to the fire, without touching the coals, and heated till the brass is seen to run.

Soldering Cast Iron to Brass.—First clean the iron and brass well, and then tin them both before placing them together for soldering. The articles can be tinned by rubbing while hot with rosin, sal ammoniac, or muriatic acid with zinc dissolved in it; then rubbing them over with solder. If done while hot, wipe the solder off with rag; sufficient will be left on the articles for the purposes required.

Solder for Gold.—1. Melt together in a charcoal fire, 24 grains gold, 9 grains pure silver, 6 grains copper, and 3 grains good brass; this makes a solder for gold ranging from 12 to 16 carats fine. For finer gold, increase the proportion of gold in the composition. To make it darker in colour lessen the proportion of the silver and increase that of the copper. 2. To 1 dwt. of gold add 6 grains of silver, if the alloy is dark; if light, 4½ grains silver, ½ grain copper. If the solder is not good, ½ grain of either silver or copper will set it right.

A Good Solder.—Take 1 lb. of pure Banca tin, and melt it, then add ½ lb. of clean lead, and when it is melted stir the mixture gently with a stick or poker, and pour it out into solder strips.

Plumbers' Solder. — Lead, 1 part; tin, 1.

Tinman's Solder.—Lead, 1 do.; tin, 1.

Pewterers' Solder.—Tin, 2 parts; lead, 1 part.

Yellow Solder for Brass or Copper.—1. Copper, 1 lb.; zinc, 1 lb. 2. Stronger;—copper, 32 lbs.; zinc, 29 lbs.; tin, 1 lb.

Solder for Copper.—Copper, 10 lbs.; zinc, 9 lbs.

Black Solder.—Copper, 2 lbs.; zinc, 3 lbs.; tin, 2 oz.

Black Solder.—Sheet brass, 20 lbs.; tin, 6 lbs.; zinc, 1 lb.

To Joint Lead Plates.—The joints of lead plates may be made as follows;—The edges are brought together, hammered down into a channel cut out of wood, and secured with a few tacks. The hollow is then scraped clean with a scraper, rubbed over with candle-grease, and a stream of hot lead is poured into it, the surface being afterwards smoothed with a red-hot plumbers' iron.

Brazing and Resetting Band Saws.—1. Get the edges to lay flush, and then braze them with a blowpipe, and file off all the superfluous solder. They should be sharpened with a three-cornered file, and the teeth cut deep. The saw should be kept tight when in use, and slacked out when done with. 2. Procure a piece of charcoal, a blowpipe, some spelter and borax, file the ends of the saw even, then file the sides so that one side laps over the other; fit the teeth opposite each other, bind it with iron wire to keep in place; moisten the

lap of the saw with borax, first dissolved in water; place the saw on the charcoal. The broken parts place by side of a gas jet, sprinkle the part previously wetted with the spelter, blow the flame of gas until the spelter runs; let it get cool before removal; when quite cold file it flat with the other part of the saw; to set the saw, drop one side on the ground, the other side up, and set on edge of the vice.

Solder for Copper, Iron, and Dark Brass.—Copper and zinc, equal parts melted together. For pale brass use more zinc.

Fine Solder.—Tin, 2 parts; lead, 1 part; used for copper and tin plates.

Glazier.—Three parts lead, 1 part tin.

Soldering Small Pieces.—Such small articles as parts of the eye-pieces of telescopes may be soldered by wetting them with a strong solution of sal ammoniac and putting a bit of tin-foil between the pieces properly placed, put on a plate of iron and held over a gas-light till the solder melts.

Removing Soft Solder from Gold.—Place the articles in a vessel containing muriatic acid and allow them to remain in about a couple of hours; the acid should be slightly warmed, say 90°. The articles would require to be recoloured or gilt afterwards. Nitric acid will dissolve solder without affecting the gold unless it be of very inferior quality.

Lute for Soldering.—A lute for the joints of iron vessels may be composed of 60 parts of finely-sifted iron filings and 2 of sal ammoniac in fine powder, well mixed with 1 part of flowers of sulphur. This powder is made into a paste with water, and immediately applied; in a few seconds it becomes hot, swells, disengages ammonia and hydric sulphide, and soon sets as hard as the iron itself.

AUTOGENOUS SOLDERING, OR BURNING TOGETHER.—The method of burning together only admits of limited application, but when successfully performed, the work assumes the condition of greatest strength, from all parts being alike. There is no dissimilarity between the several parts as when ordinary solders are used, which are open to an objection, that the solders expand and contract by heat either more or less than the metals to which they are attached. There is another objection of far greater moment; the solders oxidize either more or less freely than the metals, and upon which circumstance hinge many of the galvanic or electrical phenomena; and thence the soldered joints constitute galvanic circuits, which in some cases cause the more oxidizable of the two metals to waste with the greater rapidity, especially when heat, moisture, or acids are present. In chemical works this is a serious inconvenience, and leaden vessels and chambers for sulphuric acid must not be soldered with tin solder, the tin being so much more freely dissolved than the lead. Such works were formerly burned together by pouring hot lead on the joint, and fusing the parts into one mass, by means of a red-hot soldering iron; this is a troublesome and tedious operation.

Pewter is sometimes burned together at the angles of work, that no difference of colour may exist; one edge is allowed to stand a little above the other, a strip of the same pewter is laid in the angle, and the whole are melted together, with a large copper-bit, heated almost to redness; the superfluous metal is then filed off, leaving a well-defined angle without any visible joint.

Brass is likewise burned together; the rims of the large mural circles for observatories are sometimes cast in six or more segments, and attached by burning. The ends of the segments are filed clean, two pieces are fixed vertically in a sand mould in their relative positions, a shallow space is left around the joint, and the entire charge of the crucible, say 30 to 40 lbs. of the melted brass, a little hotter than usual, is then poured on the joint to heat it to the melting point. The metal overflows the shallow chamber or hole, and runs into a pit prepared for it in the sand; but the last quantity of metal that remains solidifies with the ends of the segments, and forms a joint as perfect as the general substance of the metal; the process is repeated for each joint of the circle.

Cast Iron is likewise united by burning. To add say a flange to an iron pipe, a sand mould is made from a wood pattern, but the gusset, or chamfered band between the flange and tube, is made rather fuller than usual, to afford a little extra base for the flange. The mould is furnished with an ingate, entering exactly on the horizontal parting of the mould, at the edge of the flange, and with a waste head or runner proceeding upwards from the top of the flange, and leading over the edge of the flask to a hollow or pit sunk in the sand of the floor. The end of the pipe is filed quite clean at the place of junction, and a shallow nick is filed at the inner edge to assist in keying on the flange; lastly, the pipe is plugged with the sand and laid in the mould. After the mould is closed, about six or eight times as much hot metal as the flange requires is poured through the mould; this heats the pipe to the temperature of the fluid iron, so that on cooling, the flange is attached sufficiently firm to bear the ordinary pressure of the screw-bolts or steam. The method of burning is occasionally employed in most of the metals and alloys, in making small additions to old castings, and also in repairing trifling holes and defects in new ones; it is only successful, however, when the pieces are filed quite clean, and abundance of fluid metal is employed, in order to impart sufficient heat to make a natural soldering.

Waterproofing.—*For Cloth.*—1. Moisten the cloth on the wrong side with a weak solution of isinglass, when dry apply an infusion of nut-galls. 2. Apply a solution of soap to the wrong side of the cloth, when dry go over again with a solution of alum. 3. Sievier's Process;—Apply a solution of india-rubber dissolved in oil of turpentine, then lay on a coat of another india-rubber varnish made very drying by the addition of driers. 4. 1 lb. of sugar of lead, 1 lb. of alum; pound separately, and mix in a basin; pour 2 quarts of boiling water on the mixture, let it stand 6 hours, and then bottle off for use. Apply to the cloth with a sponge or soft brush on a table till well saturated, and then iron it over and hang up to dry. 5. Take 3lbs. of alum, and dissolve it in water, and to it add 1 lb. of acetate of lead previously dissolved. Let this stand till clear, then pour off the clear solution on to 1 lb. of glue previously dissolved in water. Heat up to 185°, and place the cloth in for about ¼ of an hour; take it out and place in running water, afterwards dry.

To make Cotton Waterproof.—To do this, without making it sticky, it must be dried at about 150° Fahr. by artificial heat. The sun will do it on a hot day. Set as much boiled oil as is necessary, mix enough lampblack to blacken it, if for black work; if yellow, use ground yellow ochre instead. Then lay the fabric on a smooth surface, and put the oil on with a brush, a shoe-brush is best; let the first coat get quite dry before putting on another. A little patent driers will make it dry quicker, say ½ lb. to a gallon of oil; if the last coat remains sticky after it is dry, take shellac 1 lb. to 2 quarts of water, simmer it gently, and when near boiling add a little liquor ammonia to dissolve the shellac. When this is cold mix a little lampblack for black; if yellow use it as it is. If the fabric is coated over with this it will make it hard; put it on with a sponge. Lay the oil on as thin as possible or it will not dry.

Waterproofing Rick Cloths and Awnings.—Plunge the fabric into a solution containing 20 per cent. of soap, and afterwards into another solution containing the same percentage of sulphate of copper; wash, and the operation is finished.

Waterproof Cart-coverings. — The sheets used for covering railway and other wagons are rendered waterproof by coating them with a composition of 95 galls. of linseed oil, 8 lbs. of litharge, and 7 lbs. of umber, boiled together for 24 hours. The mixture may be coloured by the addition of 8 lbs. of vegetable black.

To Repair Oilskins.—If they are not painted, give them another coat of the

original liquids. The best is made by dissolving 1 oz. of beeswax in 1 pint of the best boiled linseed oil over a gentle fire, applying it when cold with a piece of rag, rubbing it well in, afterwards hanging it up to dry, which will take about 4 days. If they are painted, the best plan is to give them another coat of good black paint.

Waterproofing Fishing-lines.—Two parts boiled oil, 1 part gold size, put in a bottle, shake well, and it is ready for use. Apply with a piece of flannel; expose to the air, and dry. After using the line two or three times it should have another coat, the application being repeated when necessary.

Waterproof Paper.—Dissolve 8 oz. of alum and 3¾ oz. of Castile soap in 4 pints of water, and 2 oz. of gum arabic and 4 oz. of blue, separately, in 4 pints of water; mix the solutions, heat slightly, dip in the single sheets, which hang up until dry.

Waterproof Solutions.—1. India-rubber in small pieces, 1 oz.; boiled oil, 1 pint; dissolve by heat, then add 1 pint hot boiled oil stir well, and cool. 2. Of beeswax and yellow rosin, 2 oz. each; melt in 1 pint boiled oil. 3. Of white wax and spermaceti each 1 oz.; 4 oz. mutton suet; melt in 1 pint of olive oil. These solutions should be applied to the articles warm, and may be used for waterproofing leather work of all descriptions.

Waterproof but not Airproof.—1. Potter's Process;—Cover the wrong side of the cloth with a solution of isinglass, alum, and soap; when dry brush against the grain, and go over with a brush wetted in clean water. 2. Cooley's Process;—Spread the cloth on a smooth surface, wrong side up, rub it over with pure beeswax free from grease, until an even but thin coat is applied, then pass a hot iron over it, and brush whilst still warm. Wearing apparel thus coated is waterproof, and has the advantage of not being impervious to air, the great drawback of ordinary mackintoshes and waterproof articles.

Manufacture of Floor-cloth.—The main part of the manipulation is similar to calico-printing, the figures upon the blocks being upon a much larger scale, and the cloths which are printed being of much greater size. The common dimensions of a floor-cloth are 210 or 220 square yards, and hence the immense size and often unseemly appearance of floor-cloth works. A stout canvas is chosen in the first instance. This is nailed to one extremity of a wooden frame, and stretched by means of hooks which are attached to the other side. It is then washed with a weak size, and rubbed over with pumice-stone. No other substance has yet been found which answers the purpose so well as this mineral. The next step is laying on the colour, which is performed by placing dabs of paint over the canvas with a brush, and then rubbing or polishing it with a long peculiar-shaped trowel. Four coats of paint are thus applied in front, and three on the back of the cloth. To remove it from the frame when these processes are finished, a roller on the carriage is employed, upon which it is rolled, and conveyed to the extremity of the manufactory for the purpose of being printed. It is then gradually transferred from the roller and passed over a table which is 30 ft. long and 4 ft. wide, and as it proceeds over the table, the blocks, dipped in the appropriate colours, are applied. The colours used are ochre, umber, vermilion, and different kinds of chrome, mixed up with a little linseed oil and a little turpentine. The number of blocks applied to one pattern depends upon the number of colours. The first mode of applying the patterns was by stencil plates. Then a combination of stencilling and hand printing was used, the former process being first made use of; afterwards a block was applied, the stencilling forming the groundwork. Stencilling is now abandoned. In printing, it is necessary that the cloth should first be rubbed over with a brush, or else the colours will not adhere. Every square yard of good oilcloth weighs 3½ to 4½ lbs., each gaining by the application of the paint 3 or 4 lbs. weight, and hence the quality of this manufacture

is judged of by the weight. Whiting is often used in spurious cloths mixed with oil. Cloth prepared in this way speedily cracks and becomes useless. Good cloth, with a very stout canvas, is used for covering verandahs, and will last nine or ten years, while spurious cloth will become useless in one year. Floor-cloth is employed to cover roofs, and for gutters. In the latter case it is remarkable that water remaining in contact with it produces no injurious effect. Painted baize for tables is usually manufactured with a smooth side, and is printed with blocks of a fine structure, resembling calico blocks. Fine canvas is employed; several coats of paint are laid on upon one side, and the other receives one coat, and is then strewed over with wool, or flocked, as it is called.

Rendering Wood Incombustible.—1. Deal boards become almost incombustible when painted over with a diluted solution of waterglass or silicate of soda. The waterglass is usually sold as a thick fluid, like honey. This may be thinned out with water, about six or seven times its own bulk. The water must be soft—boiled water will do—and apply the solution warm. In about 24 hours apply a second coat, and perhaps a third. Use a new brush, and wash in clean water after using, or it will get too soft. Avoid grease or fat on the boards before painting them. 2. Soak the wood in a strong solution of alum and sulphate of copper. About 1 lb. of alum and 1lb. of sulphate of copper should be sufficient for 100 gallons of water. These substances are dissolved in a small quantity of hot water, then mixed with the water in the vessel in which the wood is to be steeped. The timber to be rendered fireproof can be kept under the liquor by stones or any other mode of sinking it. All that is required is a water-tight vessel of sufficient dimensions to hold enough of the liquor to cover the timber, which should be allowed to steep for about 4 or 5 days. After this it is taken out and allowed to dry thoroughly before being used. 3. A plan of rendering the wood partially fireproof is to whitewash it two or three times.

Glue to Resist Fire.—Mix a handful of quicklime in 4 oz. of linseed oil, boil to a good thickness; then spread on tin plates in the shade and it will become exceedingly hard, but may be easily dissolved over the fire, and used as ordinary glue.

Ivory.—*Bleaching Ivory.*—Ivory is very apt to take a yellow-brown tint by exposure to air. 1. It may be whitened or bleached, by rubbing it first with pounded pumice-stone and water, then placing it moist under a glass shade luted to the sole at the bottom, and exposing it to sunshine. The sunbeams without the shade would be apt to occasion fissures in the ivory. The moist rubbing and exposure may be repeated several times. 2. Immerse for a short time in water slightly mixed with sulphuric acid, chloride of lime, or chlorine, or it may be exposed in the moist state to the fumes of burning sulphur, largely diluted with air. Ink stains may be removed by repeatedly using a solution of quadrozalate of potassa in water.

Dyeing Ivory Black.—If the ivory is well washed in an alkaline ley, and is then laid for several hours in a dilute solution of neutral nitrate of pure silver, with access of light, it will assume a black colour, having a slightly green cast. 2. A still finer black may be obtained by boiling the ivory for some time in a strained decoction of logwood, and then steeping it in a solution of red sulphate or red acetate of iron. 3. Immerse frequently in common black ink.

Blue.—When ivory is kept immersed for a longer or shorter time in a dilute solution of sulphate of indigo, partly saturated with potash, it assumes a blue tint of greater or less intensity.

Green.—1. This is given by dipping blued ivory for a little while in solution of nitro-muriate of tin, and then in a hot decoction of fustic. 2. Boil in solution of verdigris in vinegar until dark enough.

Yellow is given by impregnating the ivory first with the above tin mordant,

and then digesting it with heat in a strained decoction of fustic. The colour passes into orange, if some Brazil wood has been mixed with the fustic. A very fine unchangeable yellow may be communicated to ivory by steeping it 18 or 24 hours in a strong solution of the neutral chromate of potash, and then plunging it for some time in a boiling-hot solution of acetate of lead.

Red may be given by imbuing the ivory first with the tin mordant, then plunging it in a bath of Brazil wood, cochineal, or a mixture of the two. Lac-dye may be used with still more advantage to produce a scarlet tint. If the scarlet ivory be plunged for a little in a solution of potash, it will become cherry-red.

Violet is given in the logwood bath to ivory previously mordanted for a short time with solution of tin. When the bath is exhausted, it imparts a lilac hue. Violet ivory is changed to purple-red by steeping it a little while in water containing a few drops of nitro-muriatic acid.

Brown, as for black, using a weaker solution of silver.

Purple.—Steep in a weak neutral solution of terchloride of gold, and then expose to the light. With regard to dyeing ivory, it may be observed, that the colours penetrate better before the surface is polished than afterwards. Should any dark spots appear, they may be cleared up by rubbing them with chalk; after which the ivory should be dyed once more to produce perfect uniformity of shade. On taking it out of the boiling-hot dye bath, it ought to be immediately plunged into cold water, to prevent the chance of fissures being caused by the heat.

Artificial Ivory.—Make isinglass and brandy into a paste, with powdered eggshell, very finely ground. Give it any desired colour; oil the mould, into which the paste must be poured warm. Leave the paste in the mould until dry, when its appearance strongly resembles ivory.

Flexible Ivory.—Immerse the ivory in a solution of pure phosphoric acid, sp. gr. 1·13, until it partially loses its opacity, then wash in cold soft water and dry. This renders ivory very flexible, but it regains its hardness if long exposed to dry air. Its pliability may, however, be restored by immersion in hot water.

To Prepare Ivory for Miniature Painting.—It is usual to paint miniatures upon ivory which is sold prepared for the purpose by the artists' colourman, after being subjected to a bleaching process by boiling, or exposure to the rays of the sun; but the bleaching can be more expeditiously performed by placing the ivory before a good fire, which will dispel the wavy lines, if they are not very strongly marked, that frequently destroy the requisite uniformity of surface. Ivory of the best quality has but few of these wavy lines, but it is frequently expedient to employ that of inferior quality.

Defective Ivory.—By holding the ivory up to the light, it will be seen whether there are any specks or holes in it; if any exist, they will be fatal to the success of the painting. It is often necessary to remove the defects found in the ivory in the state in which it is sold. To remove the marks of the saw, scrape the surface equally in every direction with an eraser, or an old razor with a fine edge, by which the marks of the saw are removed; then, with a piece of fine cork, or a roll of paper, dipped in finely pulverized and sifted pumice, or tripoli powder and water, rub the ivory with a circular motion in every direction, until the surface presents one uniform tint, but it must not appear polished; finish with a stump and a little cuttlefish powder carefully sifted; then, with a large camel-hair pencil and water, wash the surface of the ivory, and it will be ready to receive the colours. To render the ivory perfectly flat, place it between two pieces of white paper, and subject it to pressure by placing a weight upon it.

Mounting.—The ivory should be fastened at the four corners to a piece

of cardboard, for the convenience of painting on; the back of the ivory should be kept perfectly clean, as any application of gum or glue to its surface destroys the transparent quality upon which its usefulness depends. After the surface to be painted on is properly cleaned, it should be on no account touched with the fingers, as the employment of ox-gall to remove greasiness must be scrupulously avoided. An ivory palette is best adapted for miniature painting, because the tints appear on it the same as when worked on the miniature, a matter of considerable importance.

Soaps.—When fats or oils are heated with caustic leys, a combination of fatty acids with alkali is formed; this is designated saponification. Soaps are divided into hard and soft, the former having soda, and the latter potash, for their bases. The former, however, is the most extensively manufactured, whilst the demand for the latter is limited. Acids decompose soaps, combining with their base and expelling the fatty acids, for these being insoluble in the former, float on the surface of the liquid. By this means soaps are easily analyzed.

VEGETABLE OILS.—Vegetable oils have been divided into two classes, the drying, and the fluid oils. Of the first-named are oil of linseed, hempseed, and poppy oil. Of the second, olive oil, palm oil, sweet almonds, and cocoanut oil. According to the mode of obtaining oils, they are distinguished as oils of the first and second pressure. Those of the second pressure are more serviceable to the soap manufacturer, for though less liquid and often mucilaginous, they contain more stearine, and the richer the oils are in stearine, the harder are the soaps they yield.

Cocoanut Oil.—Six fatty acids have been discovered in the cocoa butter, most of which being solids, accounts for the great firmness of the soaps it forms. This fat is also remarkable as uniting with soda leys in any proportion, without separating from them. Owing to this property, this fat is used in large quantities for the making of filled soaps. It is very slow to unite with ley by itself; it is therefore usually applied in combination with tallow or palm oil, increasing their emollient properties, and also giving to the tallow soaps a brilliant whiteness.

Palm Oil.—This is of an orange colour, and when not rancid, of a violet odour. Palm oil is employed both in the bleached and in the natural state. In the bleached state it produces a soap of most beautiful whiteness, and rich with the characteristic odour of the oil.

Bleaching Palm Oil.—The bleaching of 1000 lbs. requires 5 lbs. red chromate of potassa, 10 lbs. strong hydrochloric acid, and $2\frac{1}{2}$ lbs. sulphuric acid. First, the chromate of potassa is pulverized and dissolved in hot water. The palm oil should then be transferred to a wooden tank, and heated with steam to 120° Fahr. The steam is turned off and a portion of the solution of the chromate of potassa is added, agitated, and a proportional portion of hydrochloric acid used; at last the sulphuric acid. After thoroughly agitating this mixture for a few minutes, the oil changes in colour, becoming first black, then dark green, and soon afterwards light green, when a thick froth appears on the surface, an indication of the completion of the process. If a sample, when taken out and allowed to settle, does not appear sufficiently bleached, an additional portion of the bichromate of potassa, with muriatic and sulphuric acids, should be added. The whole has to be left quiet for 1 hour, so that the solution of the resulting salts may settle. The clear oil is then drawn off into a wooden cask, mixed with some water, and heated again by the introduction of steam. It is again left alone for some time, and the fat subsequently drawn off. In making soaps palm oil is usually employed with tallow, in the proportion of 20 to 30 of the former to 100 parts of the latter. It is also employed in making rosin soap, to correct the flavour of the rosin and brighten the colour.

Olive Oil.—There are three kinds,

namely, the virgin oil, obtained by a gentle pressure of the fruit; a second kind, gained by submitting them to the action of hot water and pressing them between metallic plates previously heated; and the third, an inferior kind, is the product of this residuum when boiled in water. Only the two latter kinds serve in the manufacture of soaps; they yield an excellent soap, esteemed for its fresh and agreeable odour. It is very extensively used by soap manufacturers in Marseilles and for Windsor soap.

Oil of Poppy.—It is whitish yellow, of an almond taste, and is especially used for the manufacture of soft soaps; and in France it is employed with tallow for the manufacture of an imitation Marseilles soap.

Mafurra Tallow.—It has a yellow colour, and an odour similar to cocoa butter. It is less fusible than tallow, and with the alkalies forms a brown soap. It contains a large percentage of solid fat.

ANIMAL FATS.—There is a great difference in the consistency of animal fats, the richer they are in solid constituents the higher is their melting point. In the class of whale fishes the fats are generally fluid; in the carnivorous animals, soft and rank-flavoured; nearly scentless in the ruminants; usually white and copious in well-fed young animals; yellowish and more scanty in the old. The fat of the kidneys is generally harder and more compact than that found in the cellular tissues and in the bowels of animals. The colour and odour of the fats, of course, affect the manufacture of soaps.

Beef Tallow.—This is the most used of all animal fats; it has a yellow tint, due to colouring matter, separable by several washings in hot water, and is firm, brittle, but not so white as mutton suet. That rendered by steam is generally the whitest.

Mutton Suet.—Mutton fat is richer in stearine than beef tallow, and is consequently much sought after by tallow as well as stearine candle manufacturers. Saponified with soda ley it yields a beautiful white soap, but being so rich in stearine it is liable to become too hard and brittle. In order, therefore, to obtain a more unctuous product it is generally mixed with about 20 per cent. of lard or cocoanut oil, whereby a superior soap is obtained.

Lard.—Lard is an excellent material for soap manufacturers; it forms a white, sweet, and pure soap. For the purpose of rendering it more frothing it is saponified either with tallow or cocoanut oil.

Horse Fat.—The soap made from horse fat, after several successive boilings, is white and firm; but owing to its peculiar odour it can only be advantageously employed in the preparation of palm and rosin soap.

Bone Fat.—Bones contain about 5 per cent. of fat, brownish white in colour, and of an oily consistency. Only fresh bones are adapted for the extraction of fat. They are generally split up lengthways by a hatchet, boiled in water, by means of which the fat is extracted, decantered, and filtered. For purifying bone fat, melt the fat and a small quantity of saltpetre together, and afterwards add sufficient sulphuric acid to decompose the latter. The mass scums very much, becomes of a light yellow colour, loses its noxious smell, and furnishes a fat well adapted for soaps.

Fish Oil.—Fish oil is used as a burning fluid, for making soft soaps, and for adulterating other oils.

Sperm Oil.—Sperm oil is found in commerce bleached and unbleached, the latter having a brownish appearance and disagreeable odour. It is easily saponified, and the resulting soap is readily soluble in water.

Oleic Acid.—There are two kinds in commerce. The one formed by the process of distillation is only fit for making soft soap, owing to its disagreeable odour, whilst the other, the result of simple pressure, yields soaps of great consistency, whether saponified alone or with an admixture of tallow or other fats. It often contains a small amount of sulphuric acid, hence it ought to be washed with some weak ley before using it.

Elaidic Acid.—By the action of hyponitric acid upon oleic acid, a pearly white crystalline substance is obtained of the consistence of tallow, and termed elaidic acid. It has been found equally serviceable to both soap and candle manufacturers.

OF POTASSA, SODA, AND CAUSTIC SODA.—*Potassa.*—This is called in commerce vegetable alkali, sal tartar, pearlash, potash, and hydrated protoxide of potassium. The sal tartar is simply purified pearlash. Potash is derived from certain plants, and especially from forest trees. These are cut down, converted into ashes, and lixiviated. The liquor thus obtained is evaporated until it is brought to a solid state. This residue is subjected to the heat of a reverberatory furnace, for the purpose of drying it completely and freeing it from its sulphur and organic particles. In this state it is sold as pearlash.

Soda.—Soda is of more importance to the manufacturer of soap than potash, because he could not make hard soap without it. The amount of native soda is gradually decreasing, and inadequate to supply the increasing demand. A small quantity is produced from the incineration of certain plants, but the largest portion now used is acquired from the transformation of salt. The best quality of native soda is generally imported from Spain and the Levant, and known as barilla. It contains from 15 to 30 per cent. of carbonate with a little sulphuret, and is mixed with sulphate and muriate of soda. It is considered superior to the artificial, as the hard soap made with it is found to be less brittle and more plastic.

Soda Ash.—The method of manufacturing soda ash is based upon the preparation of sulphate of soda from salt, its transformation into crude carbonate of soda, designated black ash, and the purification of the crude soda by lixiviation, evaporation, and calcination. The product thus obtained is white ash, or soda ash.

Caustic Soda can be purchased either as a solid or a liquid. In the latter state it is called concentrated ley, and soapmakers find it a convenient commodity, as it saves them the trouble of preparing it themselves. A certain weight of caustic soda represents a larger amount of soda combining with the fats than the ordinary soda. Both red and white are of equal value, for when the red caustic soda is dissolved, the colouring matter generally settles at the bottom, and the liquid becomes entirely clear.

TESTING THE CHEMICALS.—To estimate the commercial value of soda ash or potash, or solid caustic soda, it is necessary to ascertain the amount of water they contain, the amount of caustic and carbonated alkali; the foreign substances in them.

To Estimate the Amount of Water.—One hundred grains of the alkali are heated in an iron capsule over suitable heating apparatus, until all the water is expelled, which may be tested by a plate of cold glass held for a moment over the capsule, when whatever vapour rises from the heated material will be condensed on its surface. After all the water is thus driven off, the loss of weight will indicate the amount of water in every 100 grains of material, and the absolute weight of the dried sample will be the percentage of alkali contained in the crude material; the loss will indicate the percentage of water contained therein.

To Estimate the Amount of Caustic and Carbonated Alkali.—It is very important to ascertain if there is only caustic alkali or only carbonated alkali, as well as the amount of each. For example, if a potash or soda is only one-third caustic, and two-thirds carbonated alkali, the latter must be changed into the caustic state before it can be used in soapmaking. It is best first to determine the amount of caustic alkali. Concentrated alcohol will only dissolve caustic soda, and not in any way affect the other ingredients always found in commercial potash, soda, or caustic soda. Take 100 grains of commercial soda, reduce them to powder in a glass mortar, put half of it in a flask, with the addition of 1 oz. of alcohol of 95 per

cent.; shake all well together, and let stand for a few hours, afterwards transfer the liquid floating on the top carefully into an evaporating capsule of porcelain, and let it quickly evaporate over a lamp, gradually increasing the temperature until nothing more evaporates; when cooled, immediately weigh the capsule to ascertain the actual amount of caustic soda which the sample contained. Before the evaporating process is commenced, in order that nothing is lost, a little alcohol should be mixed with the deposit in the flask, and being filtered added to the liquid which had already been transferred. In estimating the amount of carbonated alkali, it is requisite to determine, first, the actual amount of alkali existing in the soda or potash, and this being ascertained, the quantity of carbonated alkali is reduced by calculation. Fifty grains of the alkaline sample are to be dissolved in a flask containing 2 oz. of water. Next weigh out, on a watch-glass, 100 grains of well-crystallized oxalic acid, reduced to a fine powder. Small portions of this powder are to be added at a time to the alkaline solution, shaking the liquid between each addition, or stirring it with a glass rod, heating and testing it with litmus paper till the latter becomes slightly reddened, while the liquid is hot. The residue of the oxalic acid is then weighed, and supposing it is 43 grains, it is obvious that to saturate the alkali in the 50 grains of the sample, 57 grains of oxalic acid were consumed; 7·87 grains of oxalic acid are capable of saturating or removing the alkaline reaction of 5 grains of caustic soda, or 7 grains of caustic potassa.

To Determine the Nature of Foreign Ingredients.—These may be soluble or insoluble. As they are not taken up by the ley, the soapmaker need care nothing about the insoluble substances. Generally the soluble ones are found to be chlorides or sulphates. The former are detected by adding a solution of nitrate of silver to a clear solution of the substance to be examined, which has been previously slightly acidulated with chemically pure nitric acid, and if there is chloride of potassium or salt present, a white curdy precipitate will be formed, which, by exposure to light, becomes first violet, and afterwards black. Sulphates are detected by first neutralizing the solution with nitric acid and then adding a solution of chloride of barium, a fine heavy white precipitate is formed. To many it is of importance to ascertain if there is any sulphide of sodium, because a potash or soda containing it would be unfit for the manufacture of white soap. It is often detected in the potash and soda, but never in the caustic soda. Its presence will be indicated by the development of hydrosulphuric acid, on adding an acid to a solution of the alkali, a gas very much resembling rotten eggs in its smell. Where the odour of the gas fails to afford sufficient proof of the presence of hydrosulphuric acid, the application of the following reagent will remove all doubt. The air suspected to contain it is tested by placing in it a small slip of paper, moistened with a solution of acetate of lead; if the gas is present, the slip will be covered with a thin, brownish black, shining film of sulphide of lead.

Preparation of the Leys.—*Water.*—Only spring or river water should be used in making soap. It must also be perfectly clear, otherwise clear ley cannot be produced. It must be free from organic matters, for these are often dissolved, and, though imperceptible, soon cause the water to become putrid. Nearly all waters contain mineral matters in solution. When such waters are used, though the leys are equally good, there will be a loss of material in proportion to the quantity of alkali neutralized. A water containing more than twelve grains of such substances in one gallon, should be rejected.

Leys.—Ley is an aqueous solution of caustic soda or potassa, by the agency of which the chemical decomposition of the fat and its conversion to soap are effected. Caustic soda is a commercial commodity, but it may happen that the

soapmaker will have to prepare his own leys. 1. Reduce the soda or potassa into small pieces, mix it with slacked lime, let it stand 24 hours, and then leach it out with water. For this purpose large tanks are used, having a perforated floor, placed from two to four inches above the bottom, and covered with a layer of straw, on which is poured the mixture of lime with the alkali. A faucet is inserted between this perforated floor and the bottom, by means of which the liquor can be drawn off. The leys prepared in this way are never perfectly caustic; whilst in this process more lime is requisite than when the following method is adopted, which gives a perfectly caustic soda. 2. The potash or soda, not too concentrated a solution, should be thoroughly brought together with lime-milk, this process being assisted by heat. Insoluble carbonate of lime forms, which settles at the bottom. There should not be more than about 15 per cent. of alkali in the solution, otherwise a portion of the carbonated alkali will remain undecomposed. For the thorough decomposition of the carbonates of the alkalies, the process of boiling must be continuous and uninterrupted, and the lime of a milky consistency. To ascertain whether the ley is caustic, take a test-glass full, let it stand till cool, then filter, and drop into the clear liquid some nitric acid; if it effervesces, the ley is not caustic; the boiling has to be continued till the portion taken from the kettle shows, when filtered, no escape of carbonic acid, if nitric acid be added. As soon as no carbonic acid escapes from the ley, the fire should be taken out, the liquor carefully covered, and suffered to remain undisturbed for 12 or 15 hours, so that the lime may settle. After this, the clear liquor should be transferred by a siphon into a wooden vat, lined inside with sheet lead, and having a perforated false bottom, and cock fitted near the bottom so that the clear ley may be drawn off. The lime used must not have been exposed to the atmosphere; only the quantity actually required should be slacked at a time, because the hydrate of lime, as well as the leys, loses its causticity when exposed to the air. For 100 lbs. of crystallized soda 24 lbs. of quick-lime are required; for 100 lbs. of pearlash, double that quantity; and for 100 lbs. of soda ash, 60 lbs. will be required. For the transformation of pearlash or soda into caustic leys, more or less quick-lime is necessary, according to the amount of carbonated alkalies they contain, and an excess of lime will do no harm.

KETTLES.—These are made of wood, wrought iron, cast iron, or bricks, lined with glazed stone. Their dimensions vary, but the larger the kettle the better, as much labour, fuel, and ley are thus saved. The shape is cylindrical, widest at the top, having a faucet for the purpose of discharging the spent ley.

Brick Kettles are best in one respect, they retain heat the longest during the paste operation. The bottom of these can be composed of brick when steam is employed, in other cases a metallic bottom is necessary. If steam is employed, the superheated is preferable, as it can be introduced directly into the material, assisting the heating process, and causing a more forcible agitation of the ingredients than manual exertion can accomplish.

Cast-Iron Kettles are used in small factories. In large establishments the lower portion is made of cast iron, and the upper of wood or brick. In purchasing kettles entirely of cast iron, the thinnest should be selected, as they are always composed of finer grain, and can be more easily filed than the thicker.

Sheet-Iron Kettles will last longer than cast iron. Those of the best soft sheet iron should be selected, the bottom piece being from $\frac{3}{8}$ to $\frac{1}{2}$ in. in thickness, and the sides from $\frac{3}{16}$ to $\frac{1}{4}$ in., according to the dimensions. A soft sheet-iron boiler, carefully cleaned after each operation, will last 5 or 6 years, or longer, without requiring any repairs.

Heating the Pans with Open Fire.—

In kettles for soap boiling, the heat must be confined to the bottom, for if it is allowed to circulate round the sides, the ingredients will be burnt. In order to concentrate the heat, it is necessary that the grate is placed in the centre of the hearth and vertically below the kettle. The inside of the fireplace must be built of refractory bricks, so that the heat may be thrown back below the bottom of the kettle. The fuel employed must be that which produces the most heat and the least flame, hard coal should be selected. The openings through which the products of combustion enter the chimney should possess together the same surface as the grate; this is the best way to obtain a good draught and effect a complete combustion of the fuel.

Heating Pans with Steam. — Both ordinary and superheated steam are employed; the latter is preferable, because the heat can then be introduced directly into the material, whereas ordinary steam has to be condensed through a worm, or conveyed intermediately under a kettle with a double bottom, and a tub for the discharge of the condensed vapour. By applying superheated steam both time and fuel are saved; high-pressure steam mingling with the fat increases the necessary agitation of all the ingredients, thus expediting saponification. A steam-boiler 8 ft. long and 3 ft. in diameter, with two atmospheres pressure, will manufacture weekly 100 cwt. of soap. Among other advantages of steam, not only can wooden vessels be used, but the temperature can be regulated by stopcocks; the fats combine more readily and rapidly with the alkalies; the boiling is uniform throughout the whole mass, and the soap never burns.

Boiling Soap. — *The Paste.* — This operation is to produce a preliminary combination of fat and ley. Some soapmakers use during the whole operation a ley of the same strength, while others commence with a weak ley, then use one of middle strength, and finish with a strong one. In the first case, a ley is employed of 10 to 15° B. In the second, of 7 to 10°, 15 to 18°, and 18 to 25° B., successively. In some cases, as for red oil soap, very strong leys are employed, say of 25 to 30° B.; usually the fat is first put in the pan and then the ley is added. For the paste operation, no leys should be used containing foreign salts, such as are found in inferior kinds of soda, for it is then very difficult to form a union of the fats with the ley, and no good sud is obtained. But when the soap has been separated from the ley by salt, leys containing salt may be used. In saponifying red oil, salty leys may also be employed from the beginning. It is imperative in all operations that the ley should be caustic, because carbonate of soda will not unite with fat. For transforming 100 lbs. of fat into soap, about 14 lbs. of caustic soda are necessary, but generally more is employed, because the soda used is never a pure hydrate of soda. The quantity of ley taken is also differently regulated by the manufacturers. Some add the whole amount of ley at the commencement, others add it gradually in small quantities. This last mode is preferable. From time to time, in order to test it, a drop of the paste should be put on the tip of the tongue, when, if there still is free alkali in it, a burning sensation will be produced, in which case the boiling must be continued until the soap gives a sweetish taste. More ley should then be added, under constant stirring, until the entire quantity is consumed. At this stage the contents of the kettle are transformed into a homogeneous, clear liquid, in which neither ley nor fat can be discovered. If the liquid is perfectly clear, it shows that the right proportion of fat and ley has been applied. Should saponification progress too slowly, a weak ley of from 1 to 2° B. may be added, and soap scraps will facilitate the combination of the fat with the alkali. By heating with an open fire, it sometimes happens that a portion of the paste, when it thickens, sticks to the bottom of the vessel and burns. This is indicated by a black smoke passing off here and there with the vapour. When this occurs, the fire should forth-

with be reduced, and some gallons of the strongest ley added to prevent further mischief. By these means a slight separation of the soap from the ley is occasioned, and the contact between the former and the metallic surface destroyed. In all cases the paste operation is complete, when, on taking out the stirring rod, the paste no longer drops from it, but slides down in long threads.

Cutting up the Pan.—This is done by stirring into the ingredients of the soap-kettle either soda ley containing salt, or a solution of salt, or dry salt. The separation is founded upon the insolubility of the soap in brine or strong caustic leys, whereas weak leys would dissolve it. Of all soaps the cocoanut oil is the most remarkable, for, being dissolved by a brine solution, it is peculiarly serviceable for washing in salt water, whence its name, marine soap. This soap becomes so hard, that when separated from the glycerine, it cannot be cut with a knife, and consequently the salting operation should not be performed, but the soap boiled in strong ley with one water. The following is the method by which the salting operation is effected;—One workman gradually adds the brine or dry salt, while another agitates the paste with a stirring rod from below upwards. This is done under gentle boiling. It is essential to add the salt in the right proportion; the whole amount requisite should not be stirred in at once, but in portions of about one-sixth. After half of it has been dropped in, the soap should be allowed to boil for about 10 minutes before any addition is made. According to concentration, 12 to 16 lbs. of salt are necessary for 100 lbs. of fat, to separate the formed soap from the surplus of water. The separation is perfect, when the aqueous portion is observed to run off from the curdy mass; when a sample is taken with a spatula, it is not of an adhesive character whilst hot; and when, on placing some in the palm of the hand, and rubbing it with the thumb, it hardens into firm scales. The termination of the process is also indicated when the surface splits up into several fields, separated from each other by deep furrows, in which there is not the fresh and soft appearance of froth, but of dry slabs. The fire should be extinguished when the soap, hitherto covered with froth and bubbles, suddenly sinks, and the froth breaks up into roundish massive grains, distinctly separated from each other and from the saline solution. The salting being completed, let the mass remain quiet for several hours, and then the under-ley may be drawn off by the faucet.

Clear Boiling.—This operation is to obtain hardness, consistency, and complete neutrality of the soap. Commence to boil the paste gently with tolerably strong leys. Some manufacturers proportion the quantity of ley to be used, and having put in the first, boil for 8 hours or so, then draw off the ley, put in the second, boil again, draw off, and so on. Should the soap, during the intervals, become too liquid, which may happen if a too weak ley has been applied, some handfuls of salt must be added, or the soap boiled with a weak ley containing salt. After each addition of ley, there should be, in taking up a portion by the spatula, some difficulty in running off the ley. Should this not be the case, water must be added, whereupon a quicker union of the alkali with the fat will be obtained. The process is terminated when large, regular, and dry scales appear on the surface, and when these give elastic, brilliant, white scales, and are easily pulverized by rubbing them in the palms of the hands. The soap should then be covered, left for some time, and eventually removed in the ladles.

Marbling.—The formation of veins in the soap is produced, either as the effect of the ley itself, or by the addition of foreign substances to the soapy paste. Some kinds of sodas employed in the manufacture of soaps contain both the sulphuret of iron and sodium. In saponification a chemical combination takes place between these and the fatty acids. These diffuse themselves throughout the mass, together with black sulphuret of

iron, and being held in intimate suspension, form bluish veins in the white ground, thus giving to the soap the appearance of marble. In Castile soap these in course of time, after exposure to the atmosphere, assume a brownish colour, a change caused by oxidation. If the soda employed does not contain those constituents in itself, sulphate of protoxide of iron, or copperas, previously dissolved, is introduced into the soapy paste, say 4 oz. of the dry substance to 100 lbs. of fat. By the chemical union of this oxide with the sulphuret of sodium, always existing in the crude soda, the colouring principle of marbling is produced. Mottled soap, made as above, contains necessarily less water than any other soap, as a superabundance of water would have precipitated the colouring matter, and rendered veining impossible. For successful marbling, a thorough practical knowledge is absolutely requisite. The essential point is to run the soap into the frames as soon as it presents the indications necessary for obtaining a good marbling. The eye is the best guide in this respect, as there are no precise regulations for this operation. The interspersion of the blue with the red veins is effected by stirring some pulverized colcothar into the soap, after marbling in the ordinary way.

Pelouze's Process.—When crystallized sulphuret of sodium is brought together with neutral fats, they are saponified at ordinary temperature and in a very short time. A mixture of equal parts of crystallized sulphide of sodium, olive oil, and water, produces after 10, sometimes after 5 or 6, days a thoroughly saponified paste, consisting of soap, glycerine, sulph-hydrate of sodium, and the surplus of monosulphuret of sodium. When subjected to heat, sulphuretted hydrogen will escape, and soap remain. In this case, one equivalent of sulphide of sodium produces the same quantity of soap as one equivalent of pure caustic soda, but it is not at all necessary to make use of crystallized and chemically pure sulphide of sodium, as that which is obtained by decomposing the sulphate of soda by charcoal can be employed. It is much cheaper than the caustic soda. The appearance of the soap made in this way is exactly the same as that made in the ordinary way; but it retains a disagreeable smell not easily destroyed. For ordinary purposes, however, such as scouring woollen fabrics, this kind of soap may well be used.

Saponification by Agitation.—Hawes.—Twenty gallons of ley, of 1·125 sp. gr., are employed for every 100 lbs. of tallow. The apparatus consists of a cylinder 6 feet in diameter and 12 feet in length, and is capable of working 2½ tons of tallow. Through the cylinder, lengthwise, a shaft extends, provided with radiating arms, to which an oscillating or rotatory motion is communicated. Convenient doors are attached for charging and emptying the cylinder. After charging the vessel agitation is continued for about 3 hours, when the whole is left undisturbed for a time, and ultimately removed into an open boiler, and completed in the ordinary way.

Gossage's Process.—The boiling of the paste is effected by blowing steam into the bottom of the pan, and the mixture is treated with successive additions of stronger ley, undergoing between each a thorough boiling, until the fatty matter has taken up all the soda possible, and has thus become completely converted into soap; the excess of ley settles at the bottom of the pan, and is drawn off. The charge of soap is then drawn off from the pan without hand labour, by means of air pressure; the top of the pan is closed by a cover, the joint being made air-tight by an india-rubber packing ring, and compressed air is forced into the top of the pan by a pump, whereby the entire liquid mass of soap, amounting to as much as 20 tons, is expelled from the pan, being forced up through a discharge pipe passing through the cover, and flows through a long trough into the moulds. These are 45 inches long, 15 inches wide, and 52 inches high, each containing ½ a ton of soap, and are made simply of 4 cast-iron side-plates secured by clamps; the soap takes 3 days to cool

and solidify, and the sides of the mould being then removed, the large block of soap is cut horizontally into slabs, which again are divided into bars by a wire frame. The bars of the finer qualities are cut into cakes, which are stamped in a press having a heavy falling die lifted by a cam. The ley, or solution of caustic soda, is concentrated to the required strength for the soap-boiling pan by waste heat of the soda furnaces.

Silicated Soap.—A solution of silicate of soda is employed in place of a portion of the tallow or oil used in the soap-boiling pans, thus producing a much cheaper soap with equal cleansing power. As ordinary soap owes its cleansing power to the fact that the soda, which constitutes the real detergent, is only in a state of weak combination with the tallow or other fatty substance, the latter can be to a considerable extent replaced by silicate of soda, in which soda exists only in weak combination with silica, thereby retaining its cleansing power, as in ordinary soap. The silicate of soda, known as soluble glass, is made by melting in a reverberatory furnace a mixture of fine white sand and soda ash; the melted charge is run out through a tap-hole, and solidifies in lumps of a kind of glass, which is soluble in water.

Quality of Soaps.—A good soap is easily soluble in alcohol, leaving scarcely 1 per cent. of solid residue, and forms a gelatinous liquid in boiling water. Hard or marbled soap should not contain more than 25 per cent. of water, rosin soap not more than 40, and a soft soap not more than 52. In cocoanut-oil soaps a larger amount of water than 52 per cent. may be allowed. In yellow soap a part of the fat may be replaced by 10 to 25 per cent. of rosin.

HOUSEHOLD SOAPS.—*Hard Soaps.*—Hard soaps are always soda soaps. There are grained soaps, those in which a separation of the under-ley has been made as described, and filled soaps, those in which the whole contents of the boiling pan are kept together and sold as soap. The cocoanut oil is especially employed for the manufacture of filled soaps, because it is easily soluble in brine, requiring a very large quantity to separate them, and then they become so hard that they can scarcely be cut with a knife. The more solid constituents a fat contains, the harder the soap produced; the more oleine, the softer the soap. By mixing the fats in different proportions, soaps of any consistency can be obtained; this also depends upon the strength of the ley used in the process. Weak and middling strong leys will produce a light soap, while leys of 25° to 35° B. will produce a soap heavier than water. Sometimes a small admixture of sulphate of soda is employed in making soap, for the purpose of preventing its too great solubility when used in washing. In the manufacture of soaps, $\frac{1}{3}$ or $\frac{1}{4}$ of fat is frequently substituted by rosin. For the transformation of 100 lbs. of fat into soap, there are generally necessary $12\frac{1}{2}$ lbs. of solid caustic soda; this quantity must be more or less, in proportion to the nature of the fat.

Tallow Soaps.—To saponify 1000 lbs. of fat, commence by putting the tallow into the boiler, and melt it with a slow heat, add 70 to 80 galls. of ley of 10° to 12° B., stir well, and keep a gentle fire for several hours. Should part of the fat separate from the mass, which is often the case, an oily liquid will be observed floating on the top. Then add, gradually, 35 to 40 galls. of ley of 15° to 18° B. By this addition the whole contents will soon form a homogeneous mass of a greyish-white colour. In order to establish the necessary consistency to the paste, boil gently for several hours, adding every hour 6 to 7 galls. of ley of 20° B. The time necessary for the first operation is from 10 to 12 hours for 1000 lbs. of fat. After this, pass to the cutting process, and operate as before described. It is essential that care be taken to stir the ingredients well while adding the salt. When the separation has taken place, leave altogether quiet for several hours, and then draw off the coloured

under-ley; 90 galls. of ley of 25° should then be added; increase the heat, there being strong ley at the bottom of the pan, which preserves the soap from burning. Boil this mass from 10 to 12 hours, adding every hour 5 galls. of ley of 25°. 4 or 5 hours' boiling will often be sufficient to saturate the soap, this being accomplished, extinguish the fire, leave it quiet for an hour, and then draw off the under-ley. It will measure from 25° to 30° B. To complete the process, add about 50 galls. of ley of 4° B. Let this boil gently for $1\frac{1}{2}$ to 2 hours, stirring from time to time with the crutch, and finally extinguish the fire and cover the pan. The soap will separate from the ley, and rise to the top. After 5 to 6 hours, while yet in a liquid state, pour it in the frames, taking due care that no ley is mixed with it. In the frames it should be well stirred for some time. For neutralizing the disagreeable tallow odour, 1 to 2 oz. of a well-scented essential oil should be added to 100 lbs. of the soap, and after 7 to 8 days it may be cut. 100 lbs. of tallow will yield about 170 lbs. of soap.

Tallow Rosin Soaps.—Rosin, incorporated with a soap, to a certain amount, will make it more soluble and detersive. The lighter the rosin the more it is valued; 15 per cent. of rosin with 85 per cent. of tallow is allowable, but beyond that limit the soap loses in colour, in firmness, and quality. Even for the cheapest article the quantity of rosin should not exceed 33 per cent., otherwise the soap will be soft, and unprofitable to the consumer. The rosin can be saponified with alkali; 12 galls. of ley of 30° B. are needed for every 100 lbs. of rosin. Some soapmakers melt it with the fat at the commencement of the boiling for soap, but a much better product is obtained by first producing a tallow soap, and afterwards mixing the rosin soap with it, made in the meantime in a special kettle. Both mixtures have to be stirred and beaten thoroughly for half an hour, and the whole passed through a sieve before they are filled into the frames, and therein well stirred and crutched. Some palm oil, when saponified with the tallow, very much improves the appearance of the soap.

Rosin Soap.—Place 80 galls. of ley into a kettle of sufficient capacity, first boil the contents, and then throw rosin in at intervals of 5 or 6 minutes, and in portions of 15 to 20 lbs., until 1320 lbs. have been added. The rosin must be previously well pulverized, and while one workman is occupied with throwing it in, another should be constantly engaged in stirring it, as the mixture easily ascends. The heat must not be too rapidly increased, nor is it necessary that it should boil all the time, but keep the temperature near the boiling point. It is absolutely requisite to keep stirring the paste all the time. Saponification will be finished in 2 hours, and then the mixture, with the fat, is converted into soap as above described.

Cocoanut-oil Soap. — Cocoanut oil acts differently from any other fats, in combination with which weak leys produce a milky mixture. Such leys have no effect upon cocoanut oil, for it can be seen floating on the top, while strong leys of 25° to 30° very soon produce saponification throughout the whole mass. This soap is sometimes called marine soap, as it will lather well with sea water. A ley of 27°, cold weighed, will saponify an equal weight of cocoanut oil, 100 lbs., for instance, making nearly 200 lbs. of soap. The oil is put in the pan together with the ley, and then heat is applied. After continually stirring it for 1 or 2 hours, the paste will gradually thicken, when the temperature of the heat applied should be moderated, but the stirring continued. After a time the paste turns into a white semi-solid mass, which forms the soap, and this has to be filled immediately into the frames, because solidification takes place very quickly. A mixture is often used of equal parts of tallow and cocoanut oil, or of bleached palm oil and cocoanut oil, which yields a very fine soap. 90 to 95 per cent. of cocoanut oil, with 5 to 10 per cent. of natural palm oil, yields also a nice soap; and all these fats, when mixed with cocoanut

oil in not too large proportions, will be as easily saponified as if the latter alone were used.

Palm-oil Soaps.—Palm oil is rarely used alone as a soap stock, but generally employed with an admixture of rosin, and it then yields yellow soap; for white soap, however, these are employed in the bleached state. For some kinds of soap, palm oil is saponified with 5 to 10 per cent. of cocoanut oil; more is often used of the latter, and then filled soaps are obtained. Demi-palm is a soap consisting of equal parts of tallow and palm butter, to which is added a very small quantity of rosin and cocoanut butter. 1. Palm oil, 300 lbs.; tallow, 200 lbs.; rosin, 200 lbs. 2. Tallow, 500 lbs.; palm oil, 300 lbs.; rosin, 200 lbs. 3. Palm oil, 450 lbs.; cocoanut oil, 50 lbs. 4. Hog fat, 550 lbs.; palm oil, 150 lbs.; cocoanut oil, 50 lbs.; clarified rosin, 50 lbs. Palm oil may be made into soap exactly in the same way as tallow. If rosin is incorporated, it is better to produce first the combination of the rosin with the ley, and mix the same with the finished palm-oil soap. Soap made of bleached palm oil is perfectly white, and can scarcely be distinguished from tallow. Palm soap bleaches when exposed to the light.

Soft Soap.—For the manufacture of soft soaps, hempseed oil, linseed oil, poppy oil, rapeseed, colza, whale, and seal oils are used. Saponification is commenced with a ley of 9° to 11° B., and the contents of the kettle kept boiling until the paste becomes of sufficient consistency to draw threads out of the substance. It then undergoes the process of clear-boiling, for which purpose a ley of 25° B. should be used, stirring all the time. When the paste does not sink any more—first it ascends—boils quietly, and shows the formation of scales, it may be considered finished. The barrels in which it is to be offered to the trade should be immediately filled. The quality of soft soaps is estimated according to their consistency. Green soap was formerly made of linseed oil. It is now, however, made principally of whale oils, but as they have a yellow colour, manufacturers mix the soaps made of the whale oils with finely-powdered indigo, or the indigo-sulphate of lime, which is prepared by dissolving indigo in sulphuric acid, diluting it with water, and saturating the whole with lime-milk. Black soft soap is made by adding to the soap a mixture of a solution of copperas and logwood or gall-nuts.

TOILET SOAPS.—In the manufacture of fancy soaps the same crude materials are employed as for the common soaps, but they are in a more refined state, and the superior fats, as hog's fat, cocoanut oil, and olive oil, are substituted for the inferior. The soaps obtained are generally coloured and scented.

Making Soaps in the Cold Way.—First the fat is melted in a well-cleaned iron or copper kettle, at a low temperature, it is then filtered through fine linen or muslin into another kettle. Often the fat has to be further purified. This is done by boiling it with one-third of water for about 10 minutes, and straining it off. Some add for 100 lbs. of fat, 6 oz. of salt, 3 oz. of fine pulverized alum. They then let it remain quiet for some hours. To the fat, which must not be warmer than 104° Fahr., the ley is gradually added. In soaps made in the cold way, a very strong ley is used, generally one of 36° B., and for a certain quantity of fat just half of it employed; say, for 80 lbs. of fat, 40 lbs. of ley, or less when the ley is stronger. The ley must be clear and colourless, but it is not necessary to heat it previously when it has been kept in a warm room. For stirring it, a broad paddle of boxwood must be used, having sharp edges at its lower end, rounded at its upper end, so that it may be easily handled. The paddling should be continued until a ring drawn with the spatula may be recognized. At this point the necessary colouring matter and perfume should be added. The paste should then be run into frames previously lined with linen, so carefully that no folds are formed in the edges of the box. Each frame should be entirely

filled, and well closed with the margin of the linen and a wooden cover, and the whole left for 12 hours, by which time saponification will have been produced; it will be seen that the mass, which was nearly cold when run into the frames, has undergone a spontaneous reaction, raising the temperature sometimes over 175° Fahr. At this temperature the constituents of the materials are combined, and a soap produced of a quality almost resembling that of the boiled soaps. At the expiration of 12 hours the soap may be taken out of the frame, cut, and dried. Some add about one-tenth of potassa ley to the soda ley, for the purpose of increasing the solubility, and consequently the quality of the soap; when no potassa is added these soaps are generally hard. Of such soaps, 100 lbs. of fat will yield about 150 lbs.

Transparent Soaps are prepared by dissolving well-dried soaps in alcohol; but all kinds of soaps cannot, with equal facility, be thus transformed. It is difficult to work up into a solid consistency soaps made of olive oil, when treated with alcohol, and they invariably assume the opaque form. A good suet soap should always be preferred, and rosin tallow soaps readily yield yellow soaps of a remarkable transparency. The first step necessary for making these soaps transparent is to cut them into very thin ribbons, which can be done with a knife, or with a soap-mill. The soap is extended on strong paper, and exposed to the air and sun until it is thoroughly dried. It is then pulverized in a marble mortar, and passed through a fine sieve. The powder thus obtained is directly dissolved in strong boiling alcohol. While the soap is liquid, the colours and perfumes are incorporated with it. Three and a half gallons of alcohol of the specific gravity of 0·849 are generally used to 50 lbs. of soap. A still, heated by steam or hot water, is used for this operation, as a considerable quantity of alcohol would be lost in a common heating pan, and the direct application of fire would destroy the beauty and transparency of the soap.

Colouring Soaps.—For the colouring of ordinary fancy soaps mineral colours are employed; for superior toilet and transparent soaps, organic pigments are used. Generally, the red colouring matter is derived from vermilion or chrome red, the violet from fuchsine solved in glycerine, the red-brown and brown from camarel and the various kinds of umber. For green, chrome green is used; a beautiful vegetable green is obtained by stirring in the soap, saponified with 7 to 10 per cent. of palm oil, some smalts or ultramarine. For blue, smalts or ultramarine. Yellow is obtained by mixing palm butter with the fat to be saponified. For black, common lampblack is used. Fine toilet soaps and transparent soaps may be coloured as follows;—For a red colour, tincture of dragon's-blood or liquid carmine. Rose, tincture of carthamine or of archil. Yellow and orange, tincture of annatto or saffron. Blue and violet, tincture of litmus, or of alkanet-root, or soluble Prussian blue, basic, or a very little pure indigo in impalpable powder. Green, a mixture of blue and yellow.

Perfuming Soaps.—Perfuming is generally done when the paste is in the frame, as, if added in the pan when the soap is hot, most of the essential oils would be volatilized. It is best to mix the colours and the perfumes together with some alcohol or glycerine, and stir well in the paste.

Windsor Soap.—1. White. The best is a mixture of olive oil, 1 part; ox-suet, or tallow, 8 or 9, saponified with a ley of caustic soda, and scented after removal from the boiler. The ordinary is curd soap, scented, whilst semi-liquid, with oil of carraway, supported with a little oil of bergamot, lavender, or origanum. To the finer qualities a little oil of cassia, or of almonds, or of the essences of musk and ambergris, is also added. The usual proportion of the mixed oils for good qualities, is 1½ lb. per cwt., and 2 lbs., at the least, for the finer ones, exclusive of the alcoholic essences, if any are employed. 2. Brown. Originally this was the white variety that had become yellow and brown by age. It now only differs

from the white in being coloured with a little caramel, with umber, or brown ochre. 3. Nine parts of good ox-tallow and 1 of olive oil, scented with oil of carraway, oil of lavender, and oil of rosemary, in the following proportions;—Hard curd soap, 100 oz.; oil of carraway, 1 oz; oil of lavender, $\frac{1}{4}$ oz.; oil of rosemary, $\frac{1}{4}$ oz.

Honey Soap.—Ordinary honey soap is the finest bright-coloured yellow rosin soap, coloured by the addition of a little palm oil or palm-oil soap, and scented with oil of rose geranium, or oil of ginger-grass, or with a little oil of bergamot or verbena. Some of the finer kinds are made of olive-oil soap and palm-oil soap, of each 1 part; white curd soap, 3; deepened in colour, whilst in a liquid state, with a little palm oil, or annatto, and scented with 1 to $1\frac{1}{2}$ oz. of essential oils to each $\frac{1}{2}$ lb., or 1 to $1\frac{1}{2}$ lb. to each cwt.

Musk Soap.—1. The basis is generally a good ox-suet or tallow soap; the scent, essence of musk or oil of musk, supported with a little of the oils of bergamot, cinnamon, and cloves. The quantity of the essence used depends on the intended fragrance of the product. The colouring matter is usually caramel. 2. Tallow and palm-oil soap, to which add powder of cloves, roses, and gillyflowers, each 4 oz.; essence of bergamot and of musk, each $3\frac{1}{4}$ oz.; colour, brown ochre, 4 oz.

Glycerine Soap.—1. Any mild toilet soap, with which about $\frac{1}{25}$th to $\frac{1}{20}$th of its weight of glycerine has been intimately mixed whilst in the liquid state. It is generally tinged of a red or rose colour, or orange-yellow. Scent with oil of bergamot or rose geranium, supported with a little oil of cassia, or cassia supported with essential oil of almonds. 2. 40 lbs. of tallow, 40 lbs. of lard, and 20 lbs. of cocoanut oil, are saponified with 45 lbs. of soda ley and 5 lbs. of potash ley of 40° Baumé, when the soap is to be made in the cold way. To the paste then add, pure glycerine, 6 lbs.; oil of Portugal, $\frac{1}{2}$ oz.; oil of bergamot, $\frac{1}{3}$ oz.; bitter almond oil, 5 oz.; oil of vitivert, 3 oz. 3. One hundred parts of oleine of commerce, pour it either in a glass flask if the quantity is small, or for a larger quantity into an ordinary boiler, add 314 parts of glycerine, sp. gr. 1·12, heat to a temperature of 90° Fahr., and then add 56 parts of an aqueous solution of caustic potassa, sp. gr. 1·34; stir the mixture well. Keep at rest for 24 hours.

Almond Soap.—1. The best quality is usually white curd soap, with an addition of $\frac{1}{9}$th to $\frac{1}{7}$th of its weight of olive-oil soap, scented with essential oil of almonds in the proportion of about 1 oz. to each $4\frac{1}{2}$ to 5 lbs., or $1\frac{1}{2}$ lb. to the cwt.; very fine. The addition of a little oil of cassia, say 4 or 5 oz. a cwt., improves it. Second and inferior qualities are scented with the artificial oil of almonds, instead of the genuine oil. 2. Hard white soap, 28 lbs.; essential oil of almonds, $4\frac{1}{2}$ oz.; reduce the soap to small shavings, and melt with the aid of a little hot water, adding the essence gradually, and with constant stirring.

Violet Soap.—1. Any white toilet soap strongly scented with essence of orris-root, either coloured, or not, with tincture of litmus, or a little levigated smalts, ultramarine, or indigo. 2. White curd soap, 3 lbs.; olive-oil soap, 1 lb.; palm-oil soap, 3 lbs.; melted together, and further scented with a little essence of orris-root, which is best added cold; and coloured, or not, at will. Very fragrant, but it does not take colour very well.

Bouquet Soap.—1. White curd soap, finest, $17\frac{1}{2}$ lbs.; olive-oil soap, $2\frac{1}{2}$ lbs.; oil of bergamot, 1 oz.; oil of cassia, oil of cloves, oil of sassafras, oil of thyme, of each, $1\frac{1}{2}$ dram; oil of neroli, 1 dram; ochre, brown, levigated, 2 oz.; proceed as for almond soap. It may be varied by substituting oil of lavender for the neroli. 2. White curd soap, 20 lbs.; oil of bergamot, $2\frac{2}{3}$ oz.; oil of cloves, $\frac{1}{2}$ dram; oil of neroli, $\frac{1}{2}$ dram; oil of sassafras, $\frac{1}{3}$ dram; oil of thyme, $\frac{1}{3}$ dram. Coloured with $2\frac{1}{2}$ oz. brown ochre. 3. Good tallow soap, 30 lbs.; essence of bergamot, 4 oz.; oils of cloves, sassafras, and thyme, each 1 oz.; colour, brown ochre, 7 oz.

Rose Soap.—1. Palm-oil soap, in shavings, 3 lbs.; finest white curd soap, in shavings, 2 lbs.; soft water, $\frac{1}{4}$ pint. Melt together in a bright copper pan, set in a water bath. Add levigated vermilion, $\frac{1}{4}$ oz.; and when the mixture has cooled a little, stir in finest otto of roses, 2 drams; oil of bergamot, $1\frac{1}{2}$ dram; oil of cinnamon, oil of cloves, of each, $\frac{3}{4}$ dram; oil of rose geranium, $\frac{1}{2}$ dram. Mix well, and pour the mass into an open-bottomed wooden frame, set on a polished marble slab. Sometimes it is coloured with tincture of dragon's-blood, or of archil, instead of with vermilion. 2. White curd soap, 20 lbs.; essence of rose, $1\frac{1}{3}$ oz.; oil of cloves, $\frac{1}{2}$ dram; oil of cinnamon, $\frac{1}{3}$ dram; oil of bergamot, 1 dram; oil of neroli, $\frac{1}{4}$ dram; coloured with 2 oz. vermilion. 3. Olive-oil soap, 30 lbs.; good tallow soap, 20 lbs.; finely-ground vermilion, $1\frac{1}{2}$ oz.; essence of rose, 3 oz.; essence of cloves, 1 oz.; essence of cinnamon, 1 oz.; essence of bergamot, $2\frac{1}{4}$ oz. The hard soaps are to be kept at 212° Fahr. for an hour, with 5 lbs. of water in an untinned copper pan, the vermilion then added, and when taken off the fire, the essences mixed well with it, by stirring them together. This is a very perfect soap, possessing a delicious fragrance, a beautiful roseate hue, and the softest detergent properties, which keeping cannot impair.

Cinnamon Soap.—1. Usually a mixture of tallow and soaps, coloured with about $\frac{1}{4}$ lb. of yellow ochre, and scented with 1 oz. of oil of cinnamon, supported with a little oil of bergamot and sassafras, to each 7 lbs. 2. Finest white curd soap, 6 lbs.; palm-oil soap, $3\frac{1}{2}$ lbs.; cocoanut-oil soap, 1 lb.; oil of cinnamon, $1\frac{1}{2}$ oz.; oil of bergamot, oil of sassafras, of each, $\frac{1}{4}$ oz.; lavender, 1 dram; levigated yellow ochre, $\frac{1}{4}$ lb. 3. Good tallow soap, 30 lbs.; palm-oil soap, 20 lbs.; essence of cinnamon, 7 oz.; essence of sassafras, $1\frac{1}{4}$ oz.; essence of bergamot, $1\frac{1}{4}$ oz.; colour, yellow ochre, 1 lb. Oil of cassia is often used instead of oil of cinnamon, and always in inferior qualities.

Lavender Soap.—The basis of Windsor soap, scented with oil of lavender, 1 to $1\frac{1}{2}$ fluid oz. per 7 lbs., supported with a little oil of bergamot and the essences of musk and ambergris. It is often coloured with a little tincture of litmus, or corresponding mineral pigments.

Orange-flower Soap. — 1. Like rose soap, but using pure neroli, supported with a dash of the essences of ambergris and Portugal, instead of otto of roses, as scent. The French orange-flower soap is scented with equal parts of neroli and geranium. 2. Tallow and palm-oil soap, to which add, essence of orange flowers, $7\frac{1}{2}$ oz.; ambergris, $7\frac{1}{2}$ oz.; colour, chrome yellow, 8 oz.; red-lead, 2 oz.

Rondeletia Soap.—The basis of cinnamon, rose, or Windsor soap, scented with 1 to $1\frac{1}{2}$ oz. of the mixed oils and essences used for essence of rondeletia, to each 7 lbs. The colours are those used for bouquet, cinnamon, honey, or brown Windsor soap.

Flowers of Erin.—White curd soap, scented with oil of roses, 1 dram; spirits of violet, $\frac{1}{2}$ fluid oz.; spirits of jasmine, $\frac{1}{3}$ fluid oz.; spirits of patchouli, $\frac{1}{4}$ fluid oz.; spirits of vanilla, $\frac{1}{4}$ fluid oz. Tinged green or rose.

Primrose Soap.—This has usually a similar basis to honey soap, faintly scented with mixed oils similar to those used as cowslip perfume, and coloured pale yellow, or greenish yellow.

Iodine Soap.—Make a solution of 1 part of iodine of potassium in 3 parts of water; to this add, of pounded Castile soap, 16 parts; melt in a porcelain vessel by the aid of a water bath.

Mercurial Soap.—Beat into a homogeneous mass in a Wedgwood mortar, Castile soap, 1 lb.; protochloride of mercury, $\frac{1}{2}$ oz. dissolved in 4 oz. of alcohol.

Sulphur Soap.—Cut into small shavings white soap, 8 oz.; beat up in a mortar with sublimated sulphur, 2 oz.; add 1 oz. of alcohol, to which may be added a few drops of any of the odoriferous essential oils; beat the whole into a smooth paste, and roll into balls.

Antimonial Soap.—Prepared by dissolving 1 part of golden sulphuret of antimony in 2 parts of a saturated solu-

tion of caustic potash, to this add, of Castile soap in powder, 4 parts, triturate till the whole assumes a proper consistency.

SHAVING SOAPS.—*Shaving Paste.*—1. White soft soap, 4 oz.; finest honey soap, 2 oz.; olive oil, 1 oz.; water, 1 or 2 tablespoonfuls; carbonate of soda, 1 dram. Melt together and form a paste, adding a little proof-spirit and scent at will. Some melt with the soap about 1 dram of spermaceti. Produces a good lather with either hot or cold water, which dries slowly on the face. 2. Hard soap in small shavings, 2 oz.; best soft soap, 6 oz.; melt by the aid of a water bath; add, on cooling, oil of cloves, 1 dram; tincture of ambergris, 20 drops.

Cream Soap.—Take white, soft, lard potash soap, recent, but moderately firm, and beat in small portions at a time, in a marble mortar, until it forms a white homogeneous mass; add sufficient essential oil of almonds, supported with a little oil of bergamot, or of cassia, put in during the pounding.

Shaving Essence or Fluid.—1. White hard soap, in shavings, $\frac{1}{4}$ lb.; rectified spirit, 1 pint; water, $\frac{1}{4}$ pint; perfume to taste. Put them into a strong bottle, cork tightly, set it in warm water for a short time, and occasionally agitate it briskly until solution is complete. After standing, pour off the clean portion from the dregs into clean bottles for use, and at once closely cork them. If the solution is not sufficiently transparent, a little rectified spirit should be added to it before decantation; a little proof-spirit may be added if it is desired to render it thinner. If much essential oil is used to perfume it, the transparency of the product will be lessened. 2. White soft soap, $\frac{1}{4}$ lb.; liquor of potassa, 2 fluid drams; rectified spirit, 1 pint. Perfume to taste. Proceed as before. The product of both is excellent. By rubbing two or three drops on the skin, and applying the shaving brush, previously dipped in water, a good lather is produced. The choice of perfume is a matter of taste, 15 to 20 drops of essence of musk or ambergris, 1 fluid dram of any of the ordinary fragrant essences, or 12 to 15 drops of essential oil, simple or mixed, to a pint, are sufficient for the purpose.

SOAP BALLS.—These are usually made of one or other of the toilette soaps with the addition of a little starch; sometimes sand is used in place of the starch.

Camphor Savonette.—Spermaceti, 2 oz.; camphor, powdered with the addition of a little spirits, 1 oz.; white curd soap, melted with a little water, 24 oz.; amalgamate with a gentle heat and mould into balls.

Sand Ball.—Fine old yellow soap, 2 parts; silver sand, 1 part; scent to taste; melt the soap and mix in the sand, afterwards adding the scent and making into balls.

Marble Working.—Marbles are generally cut up in the same direction in which they are quarried; this is known as sawing with the grain. Sometimes it is necessary to cut them against the grain, which renders them more difficult to work. Some marbles can only be sawn in the direction in which they are cut up. The marble worker is often obliged to rough hew and work without the help of the saw, casings, columns, and other articles with curved outlines; sometimes, but rarely, he re-works with the chisel badly-executed sawings; he then squares each piece with the saw or chisel to the required dimensions, and finally mounts the marble upon its stone core, and sets up the work in its place. The working of mouldings takes much time and trouble; the first operation is to saw the arris, then to work with a notched chisel, making several successive groovings, on account of the contour and expansion, in which but very small pieces of the material are taken, for fear of splintering it; finish with small common chisels, which should be sharp and well tempered. Cylindrical pieces, such as round pedestals, columns, urns, and vases, are worked with a chisel, and then, if portable, finished on a turning lathe. When it is impossible to place the pieces in a lathe, they are thickly grooved, bolstered with the puncheon, and the desired contours obtained by means of thick panels; they are then worked

with a small chisel, which removes the dust, and thus prepares the marble for polishing.

Polishing. — Polishing includes five operations. Smoothing the roughness left by the burin is done by rubbing the marble with a piece of moist sandstone for mouldings, either wooden or iron mullers are used, crushed and wet sandstone, or sand, more or less fine according to the degree of polish required, being thrown under them. The second process is continued rubbing with pieces of pottery without enamel, which have only been baked once, also wet. If a brilliant polish is desired, Gothland stone instead of pottery is used, and potters' clay or fullers' earth is placed beneath the muller. This operation is performed upon granites and porphyry with emery and a lead muller, the upper part of which is incrusted with the mixture until reduced by friction to clay or an impalpable powder. As the polish depends almost entirely on these two operations, care must be taken that they are performed with a regular and steady movement. When the marble has received the first polish, the flaws, cavities, and soft spots are sought out and filled with mastic of a suitable colour. This mastic is usually composed of a mixture of yellow wax, rosin, and Burgundy pitch, mixed with a little sulphur and plaster passed through a fine sieve, which gives it the consistency of a thick paste; to colour this paste to a tone analogous to the ground tints or natural cement of the material upon which it is placed, lampblack and rouge, with a little of the prevailing colour of the material, are added. For green or red marbles, this mastic is sometimes made of gum lac, mixed with Spanish sealing wax of the colour of the marble; it is applied hot with pincers, and these parts are polished with the rest. Sometimes crushed fragments of the marble worked are introduced into this cement; but for fine marbles, the same colours are employed which are used in painting, and which will produce the same tone as the ground; the gum lac is added to give it body and brilliancy. The third operation of polishing consists in rubbing it again with a hard pumice-stone, under which water is constantly poured, unmixed with sand. For the fourth process, called softening the ground, lead filings are mixed with the emery mud produced by the polishing of mirrors or the working of precious stones, and the marble is rubbed with a compact linen cushion, well saturated with this mixture; rouge is also used for this polish. For some outside works, and for hearths and paving tiles, marble workers confine themselves to this polish. When the marbles have holes or grains, a lead muller is substituted for the linen cushion. In order to give a perfect brilliancy to the polish, the gloss is applied. Well wash the prepared surfaces, and leave them until perfectly dry; then take a linen cushion, moistened only with water, and a little powder of calcined tin of the first quality. After rubbing with this for some time, take another cushion of dry rags, rub with it lightly, brush away any foreign substance which might scratch the marble, and a perfect polish will be obtained. A little alum mixed with the water used penetrates the pores of the marble, and gives it a speedier polish. This polish spots very easily, and is soon tarnished and destroyed by dampness. It is necessary, when purchasing articles of polished marbles, to subject them to the test of water; if there is too much alum, the marble absorbs the water, and a whitish spot is left.

Mounting.—Marble workers mount and fasten their works upon plaster mixed with a third-part of dust, as pure plaster repels the marble, and causes it to swell out and burst. These are joined together by cramps and gudgeons of iron and copper, which should be carefully covered, in order that the oxides may not spot the casings. Marble chimney-pieces should be lined with lias stone or plaster.

Selecting Marble.—Examine each piece, note its beauties, and endeavour to hide its defects before cutting or working it.

When fine pieces are found, endeavour to cut them into two or three parts, in order to multiply them, cutting them in such a manner that these happy accidents may be reproduced according to taste.

VENEERING WITH MARBLE.—*Veneering upon Wood.*—Veneering upon wood is preferable, in every respect, to that on stone. For this purpose, as marble, particularly the black, would break by heating it in the usual manner, place the slabs of marble in a caldron, tightly closed, in which let them boil. Then take them from the caldron, and after this preliminary operation, subject the marble to the heat of the fire to receive a mastic of tar. The wood having been prepared in a similar manner, press the marble, coated with the mastic, upon the wood, and a perfect cohesion is effected. The cases of ornamental clocks are hollow, for the movement of the pendulum and other works. This hollowing cannot be effected on stone without detriment to its solidity. When wood is used, a frame is made of it, upon the exterior parts of which marble is to be veneered. The mixture of glue with tar is found an improvement in effecting this veneering.

VENEERING ON METALS.—As these possess a smooth surface, the substance which should fasten them to the marble cannot incorporate itself with them intimately enough to join both and render them inseparable. It is therefore necessary to interpose between the metal and the marble a third body, which should force them to perfectly adhere; this is effected by the use of sand-paper.

Marble on Zinc.—Take a plate of zinc of about $\frac{1}{10}$ of an inch thick; make a frame of this of the form of whatever article may be wished; upon this form glue sand-paper, leaving the rough side outermost, and upon this rough side apply the marble, having first prepared it by heating in a water bath, and placing between the marble and the sand-paper a coating of mastic of tar. By this means, so perfect an adhesion between the marble and the zinc is effected, that the marble could be easier broken than removed. The application of marble upon zinc can also be effected by grooving the metal in every direction with strokes of the file, but the sand-paper produces the best results. Zinc is preferred to other metals, because it possesses resistance and cheapness, and causes no other expense in the manufacture than that of cutting up to form the model. Tin does not possess the same resistance or cheapness; sheet iron is dearer; cast iron is too heavy; copper is expensive; by the application of marble upon zinc, articles can be manufactured at the same price as those veneered upon wood. In fastening marble to the metallic plating, the tar which is used in the application of marble to stone will not be sufficient. The parts must first be heated in a water bath, or over a furnace prepared for this purpose, and then, by a sieve, sprinkled with one of the following mordants;—Crushed glass, grains of emery of all sizes, copper filings, castings of any metal, finely-rasped lead, or any kind of powdered stone, such as sandstone, marble, granite, or pumice-stone, and india-rubber, can also be used. When the sheets of metal and of marble have received sufficient mordant, join with a coating of tar, which fastens them strongly together. Any web of linen or cotton can be placed between the marble and the metal; this web being covered with grainy substances, stuck on by glue.

Marble Veneer on Boxes.—The marble is first sawn to thickness and form required for the dressing case or box to which it is to be applied. The wood, usually white wood, oak or fir, is cut a little smaller than the marble which is to cover it. This wood is lined with a shaving of beechwood, to prevent warping. This lining is only placed on the side which is to receive the marble; each piece of marble is then applied to the corresponding piece of wood, and stuck on by glue or other mastic. When the marble has been applied, the opposite side of the wood is thinly lined with rosewood or mahogany, so that

this lining forms the inside of the box, which is thus prepared for receiving the necessary divisions. The four parts are then dovetailed together, and the top and bottom parts fastened flatwise on the four sides with glue or mastic. The box being finished, the outside is pumiced and polished, and any applications of gilding can be made.

Sculpture of Marble by Acids.—Prepare a varnish by pulverizing Spanish sealing wax, and dissolving it in spirits of wine. Trace on the white marble, with a crayon, the design which is to be formed in relief, and cover this delicately with a brush dipped in the varnish; in about 2 hours the varnish will be dry. Prepare a dissolvent of equal parts of spirits of wine, hydrochloric acid, and distilled vinegar; pour this solution upon the marble, and it will dissolve those parts which are not covered by the varnish. When the acid has ceased to ferment, and, consequently, will no longer dissolve the marble, pour on some fresh, which continue until the ground is sufficiently grooved. When there are delicate lines in the design which should not be grooved so deeply, they should at first be covered with varnish, to prevent the action of the acids upon them; then, when the reliefs have been made, the marble should be well washed, and the varnish removed from these delicate lines with the point of a pin; then pour on new acid, which will groove it as deeply as desired, care being taken to remove it at the proper time. When the acid has acted upon the marble, it corrodes beneath the varnish, and enlarges the lines in proportion to its depth; therefore draw the lines in relief a little larger than it is desired to leave them. When the work is completed, remove the varnish with spirits of wine, and, as the grounds will be very difficult to polish, they may be dotted with ordinary colours diluted with the varnish of gum lac. The marble being thus grooved, the cavities may be filled in inlaid work with gold, silver, tin, sealing wax, sulphur, crushed pearl shell reduced to powder. These designs can be made either in moulding or in relief, without changing or injuring the marble; every sort of writing, however delicate it may be, can also be thus traced; and the execution is very rapid, whether in groovings inlaid with gold or silver, or in relief, which can also be gilded or silvered.

Mastic for Repairs.—Mastic for stopping up holes, leakages, or cracks in marbles, is made with gum lac, coloured, as nearly as possible, to imitate the marble upon which it is used. Sometimes the gum is mixed with marble dust passed through a silken sieve; in other cases little pieces are used, which are cut and adjusted in the hole to be repaired, and glued there with the gum mastic—the precaution being first taken to heat the marble and the pieces, and to take measures for producing a perfect cohesion.

Cement Mastic.—1. Thick mastic is composed of 2 parts wax, 3 of Burgundy pitch, and 8 of rosin; melt and throw into spring water to solidify the paste, then roll it into sticks, and, in using it, melt only so much as is immediately required, this will preserve its strength, as it becomes more brittle by repeated heating. 2. Corbel mastic is used in seams of the flagging of stairways and terraces. Six parts of the cement of good Burgundy tile without any other mixture, pass it through a silken sieve, add 1 part of pure white-lead, and as much litharge, steep the whole in 3 parts of linseed oil and 1 of lard oil, and preserve in cakes or rolls as the preceding. All the materials used should be thoroughly dry, so that they may perfectly mix with the oil which unites them. 3. Fountain mastic is made of the rubbish of stoneware or of Burgundy tile, amalgamated with thick mastic in such a manner as to form a paste proportioned to the use for which it is required; this is one of the easiest to prepare. 4. Mastic of filings is employed in places which are usually damp, or which constantly receive water, as curb stones, flaggings of kitchens, bath-rooms and water-closets, and stone troughs composed of several pieces, either separate or clasped. This mastic is composed of

26½ lbs. of iron filings, or of iron and copper, which must not be rusty, 4½ lbs. of salt, and 4 garlics; this is infused for 24 hours into 3½ pints of good vinegar and urine; it is then poured off, and the thick paste which is found at the bottom of the vessel is the mastic, which should be immediately used. These mastics should be used upon materials which are perfectly dry, otherwise they do not incorporate well. Choose dry weather, and open the seams well with a curved, sharp instrument, finally polishing them with the chisel. Before laying the mastic, remove the dust from the seam by blowing into it with bellows; a long, straight, iron chafing dish, closed at the bottom, with the grate elevated about an inch to obtain a current of air, is then passed over the seam; this chafing dish is filled with burning charcoal, the heat of which draws out the moisture from the stone or marble. The slightest dust or dampness hinders the adherence of mastic.

Cold Mastic.—Hydrochlorate of ammonia, 2 parts; flour of sulphur, 1 part; iron filings, 16 parts. Reduce these substances to a powder, and preserve the mixture in closely-stopped vessels. When the cement is used, take 20 parts of very fine iron filings, add 1 part of the above powder, mix them together, adding sufficient water to form a manageable paste; this paste, which is used for cementing, solidifies in 15 days or 3 weeks, in such a manner as to become as hard as iron.

Masons' Mastic.—Pulverized baked bricks, quick-lime, wood ashes, equal parts. Mix thoroughly, and dilute with olive oil. This mastic hardens immediately in the air, and never cracks beneath the water.

STUCCOES.—Stucco is a composition of slacked lime, chalk, and pulverized white marble tempered in water, designed to imitate different marbles used in the interior of buildings or monuments. Calcined plaster of Paris is also used. Although the plaster becomes very hard when properly calcined, it is too porous to admit the polishing of it as of marble. To remedy this, the plaster is diluted with glue or gum water, which, filling the pores, allows a polish to be given it. Some mix the glue with isinglass or gum arabic. Hot glue water is used for the solution of the plaster, as the want of solidity of the plaster demands that a certain thickness should be given to the works; to lessen expense, the body or core of the work is made of common plaster, which is covered with the composition just described, giving it about an inch in thickness. When the work is dry, it is polished in nearly the same manner as real marble. Pumice-stone may be used. The work is rubbed by the stone in one hand, the other holding a sponge filled with water, with which the spot which has just been rubbed is instantly cleansed, to remove what had been left on the surface of the work; the sponge should be frequently washed and kept filled with fresh water. It is then rubbed with a linen cushion, with water, and chalk, or tripoli stone. Willow charcoal, finely pulverized and sifted, is substituted for this to penetrate better to the bottom of the mouldings, water being always used with the sponge, which absorbs it. The work is finished by rubbing it with a piece of felt soaked with oil, and finely powdered with tripoli stone, and afterwards with the felt moistened with the oil alone. When a colour is wished in the ground, dilute it in the glue water, before making use of it to temper the plaster. When any particular marble is to be imitated, dilute with warm glue water, in different small pots, the colours which are found in the marble; with each of these colours temper a little plaster, then make of each a lump nearly as large as the hand, place these lumps alternately one above another, making those of the prevailing colour more numerous, or thicker. Turn these lumps upon the side, and cut them in slices in this direction, instantly spreading them upon the core of the work, or upon a flat surface. By this means the design of the various colours with which the marble is penetrated will be represented. In all these operations the glue water should be warm without which the plaster will

set too quickly, without giving time to work.

Wax Varnish to Preserve Statues and Marble exposed to the Air.—Melt 2 parts of wax in 8 parts of pure essence of turpentine. Apply hot, and spread thinly, so as not to destroy the lines of the figures. This varnish may be used upon statues which have been cleansed with water dashed with hydrochloric acid, but they must be perfectly dry when the application is made.

COLOURING MARBLE IN IMITATION OF MOSAIC WORK.—*Colours.*—Solution of nitrate of silver penetrates marble deeply, communicating to it a deep red colour. Solution of nitro-muriate of gold produces a very fine violet colour. Solution of verdigris penetrates marble the twelfth of an inch, giving a fine light green colour. Solutions of gum dragon and of gamboge also penetrate it; the first produces a fine red, and the second a yellow colour. To cause these two substances to penetrate deeply, the marble should first be well polished with pumice-stone, after which the substances should be dissolved in warm alcohol, and applied with a small brush. All the wood dyes made with alcohol penetrate marble deeply. Tincture of cochineal, prepared in this manner, with the addition of a little alum, gives a fine scarlet colour to the marble, penetrating it one-fifth of an inch. Artificial orpiment, dissolved in ammonia and laid on marble with a brush, quickly produces a yellow colour, which becomes more brilliant when exposed to the air. To all the substances employed add white wax; this, when placed on the marble in a melted state, soon penetrates it. If the verdigris is boiled in wax, and then laid melted upon the marble, it will be seen on its removal, when cold, that the design has penetrated the surface to the depth of from one-third to half an inch.

Application.—When several colours are to be successively used without blending them, proceed in the following manner. The dyes obtained by spirits of wine and the oil of turpentine should be laid on the marble when it is heated, particularly in the execution of delicate designs, but the dragon's-blood and gamboge may be used cold. For this they must be dissolved in alcohol, and the gamboge used first; the solution of this gum is quite clear, but soon becomes troubled and gives a yellow precipitate, which is used to obtain a brighter colour. The lines drawn by this solution are then heated by passing a chafing dish filled with lighted charcoal closely over the surface of the marble. It is then left to cool, after which the lines which have not been penetrated by the colour are heated in the same manner. When the yellow colouring has been applied, the solution of dragon's-blood, which should be concentrated as much as possible, is employed in the same manner as the gamboge; and while the marble is warm, the other vegetable tints which do not require so strong a degree of heat, may also be applied. The design is completed by the colours mixed with wax, which should be applied with the utmost care, as the slightest excess of heat will cause them to spread, for which reason they are less suited to delicate designs. In colouring marble, the pieces should be well polished, and free from any spots or veins. The harder the marble, the better it supports the heat necessary to the operation; alabaster and common soft white marble are not suitable for the purpose. Marble should never be heated to a red heat, as the fire then alters the texture, burns the colours, and destroys their beauty. Too slight a degree of heat is also bad; for though the marble takes the colour, it does not retain it well, and is not penetrated deeply enough. There are some colours which it will take when cold, but these never fix so well as when heat is employed. The proper heat is that which, without reddening the marble, is intense enough to cause the liquor which is on its surface to boil. The menstruums which are used to incorporate the colours, should be varied according to the nature of the colour employed; a mixture made with urine mixed with 4 parts of quick-lime and 1 of potash, is excellent for certain

colours, common ley of wood ashes is good for others; for some, spirits of wine, others require oily liquors, or common white wine. The colours which succeed best with the different menstruums are the following; blue-stone dissolved in six times its quantity of spirits of wine, or urine and litmus dissolved in a ley of pearlash; the extract of saffron and sap green succeed very well when dissolved in urine or quicklime, and tolerably in the spirits of wine. Vermilion and cochineal dissolve well in the same liquids. For dragon's-blood use spirits of wine, which is also used for Campeachy wood. For alkanet-root the only menstruum is turpentine. Dragon's-blood in tears gives a beautiful colour when mixed with urine alone. Besides these mixtures, certain colours can be put on dry and unmixed; such as the purest dragon's-blood for the red, gamboge for the yellow, green wax for a kind of green, common sulphur, pitch, and turpentine, for a brown colour. For all these the marble must be considerably heated, and the dry colours then rubbed upon the block. A beautiful golden colour is produced by equal quantities of the crude salts of ammonia, of vitriol, and of verdigris, the white vitriol is the best for this purpose; grind these together, and reduce them all to a very fine powder. All the shades of red and yellow may be given to the marble with the solutions of dragon's-blood and gamboge, by reducing these gums to powder and grinding them with spirits of wine in a glass mortar. When only a little is required, mix one of these powders with spirits of wine in a silver spoon, and hold it over a heated brazier; this extracts a fine colour, and, by dipping a small brush in it, the finest veins may be made upon the cold marble. By adding a little pitch to the colouring, a black shade, or all the varieties of dark red, can be given. Archil diluted in water and applied when cold to the marble gives it a beautiful blue colour; by putting on the colouring in proportion as it dries, it becomes very fine in less than 24 hours, and penetrates deeply. If the paste of archil is used, which is a preparation of the plant with lime and fermented urine, the colour obtained will be more of a violet than blue; to obtain a perfect blue it must be diluted in lemon juice; this acid will not injure the marble, as it has been weakened by its action upon the archil. Large blue veins may thus be formed upon white marble; but as this colour is apt to spread, it will not be exact unless the coloured parts are instantly touched with dragon's-blood, wax, or gamboge, which checks it.

Cleansing Marble. — Scraping marble which has been blackened or turned green by air and damp is dangerous to the design; whatever precautions may be taken, the work is always scratched more or less, and it is impossible to clean the carved parts without breaking the sculpture, or causing incongruities between the designs in relief and those which are sculptured. Soiled articles, which have not been tarnished by exposure to the open air, may be cleansed by potash water, then wash them in pure water, finish with water containing a dash of hydrochloric acid. Soap and water is often sufficient, spread on with a brush, and introduced into the sculptured parts by a somewhat stiff pencil.

To Remove Stains from Marble.—1. Take two parts of soda, one of pumice-stone, and one of finely-powdered chalk. Sift these through a fine sieve, and mix them into a paste with water. Rub this well all over the marble, and the stains will be removed; then wash it with soap and water, and a beautiful bright polish will be produced. 2. Clean with diluted muriatic acid, or warm soap and vinegar; afterwards heat a gallon of water, in which dissolve 1½ lb. of potash; add 1 lb. of virgin wax, boiling the whole for half an hour, then allow it to cool, when the wax will float on the surface. Put the wax into a mortar and triturate it with a marble pestle, adding soft water to it until it forms a soft paste, which, laid on marble, and rubbed, when dry, with a woollen rag, gives a good polish.

Restoring the Colour of Marble.—Mix

up a quantity of the strongest soap lees with quick-lime to the consistence of milk, and lay it on for 24 hours; clean it afterwards with soap and water.

Repairing Marble.—Heat the edges of the marble before a strong, clear, charcoal fire, avoiding dust or smoke, until the marble is sufficiently hot to take small pieces of shellac. Then choose a sufficient number of thin pieces, of such a size as not to project above the surface of the marble, and apply them along the edge of each piece to be joined; but in such a manner, that the bits of lac on each piece of marble will come between those on the other. Then just before applying them together, a hot iron must be passed along each piece at a sufficient distance to fuse the lac, but not to make it run. The pieces of marble must be well forced together.

Marble Cement.—Plaster of Paris, soak in a saturated solution of alum, bake the two in an oven, after which grind to powder. Mix with water.

Polishing Marble.—If the piece to be polished is a plane surface, it is first rubbed by means of another piece of marble, or hard stone, with the intervention of two sorts of sand and water; first with the finest river or drift sand, and then with common house or white sand, which latter leaves the surface sufficiently smooth for its subjection to the process of gritting. Three sorts of grit stone are employed; first, Newcastle grit; second, a fine grit brought from the neighbourhood of Leeds; and lastly, a still finer, called snake grit, procured at Ayr, in Scotland. These are rubbed successively on the surface with water alone; by these means the surface is gradually reduced to that closeness of texture, fitting it for the process of glazing, which is performed by means of a wooden block having a thick piece of woollen stuff wound tightly round it; the interstices of the fibres of this are filled with prepared putty powder, or peroxide of tin, and moistened with water; this being laid on the marble and loaded, it is drawn up and down the marble by means of a handle, being occasionally wetted, until the desired gloss is produced. The polishing of mouldings is done with the same materials, but with rubbers varied in shape according to that of the moulding. The block is not used in this case; in its stead a piece of linen cloth, folded to make a handful, this also contains the putty and water. Sand rubbers employed to polish a slab of large dimensions should never exceed $\frac{2}{3}$ of its length, nor $\frac{1}{3}$ of its width; but if the piece of marble is small, it may be sanded itself on a larger piece of stone. The grit rubbers are never larger than that they may be easily held in one hand; the largest block is about 14 in. in length and $4\frac{1}{2}$ in. in breadth.

Enamelling Slates.—The slate having been reduced to a perfectly level surface, a coating of colour is applied according to the stone it is intended to imitate. For black, tar varnish is used with good effect. The slab is then thoroughly baked in an oven heated from 130° to 250°, from 12 to 48 hours, according to size. The colours, say grey and white, are then floated on to the surface of a cistern of water over which they float naturally into the shapes of the streaks of colour seen in marble. The slate, with its black ground now burnt in, is dipped into the surface of the water, and receives from it a thin coat of colour. The slate again has to go into the oven, and when sufficiently hardened, a coating of enamel is applied. Another baking to harden the enamel, and the slab is then pumiced to reduce it to a level surface. Baked again, it is once more pumiced, and this time goes into the oven with the pumice wet on its surface. If necessary this last operation is repeated. The slab is then ready for polishing, which is effected firstly by woollen cloths and fine sand, next by the finest and softest French merino, and lastly, by the hand and powdered rotten-stone. The dipping process is not applicable to imitations of all stones. Some granites are best imitated by splashing; others by splashing and sponging combined, while some have to be hand-grained.

Bookbinding.—*Tools.*—To bind a book well, certain tools are indispensable; but very few will go a good way; and a book may be put together very decently with the aid of no other tools than a shoemaker's hammer and a glue-pot, with the addition of such implements as are usually to be met with in every household. The necessary tools for small work are: a sewing press; a cutting press, the small music-paper size; half-a-dozen pressing boards, as large as the press will admit, and as many of octavo size; as many cutting and backing boards, a bookbinder's hammer, folder, knife, small shears, saw, paste-bowl, a quire or two of demy or royal printing paper, a quire or two of marbled paper, and some leather and coloured cloths for covers. It is desirable that the book should be as thin as possible, and not have a swollen appearance when finished, the sheets ought first to be compressed. The binder does this by beating the volume in sections with a 14-lb. hammer, or passing in between the rollers of a rolling machine. Instead of that we may divide the volume in half-a-dozen sections, and placing one of the pressing boards between each, screw them all together in the press as tight as possible, and leave them there for a night. After being pressed, the sections are taken from the boards; the book is then held between the extended fingers of each hand, and the back and head knocked up square and even; one side of the book is then laid upon a pressing board, beyond which the back must project half an inch or so; a second pressing board of the same size is placed on the upper side, parallel with the first, and the boards being firmly grasped with the left hand, the book is lowered into the cutting press, which is screwed up tight, and three cuts, not quite $\frac{1}{16}$ of an inch in depth, are made with a saw in the back—one in the middle, and one at about $2\frac{1}{2}$ in. distant on each side of it; two additional cuts are then made outside of the three, and distant about $1\frac{1}{2}$ in. from them. These measurements would, of course, be different for a volume of different size, but the proportions will do for any volume.

Sewing.—The book is now taken to the sewing press, where the binder suspends three cords from the top rail, which are fastened underneath by means of brass keys, the cords may be shifted to any position, and being made to correspond with the three central cuts in the back of the book, they are tightened and kept in their place by means of the nuts and screws on the side pillars. The sewing is performed in the following manner;—First, a fly-leaf or end paper is laid on the press, and sewed to the cords by passing the needle into the first right-hand cut, or catch-stitch mark, with the right hand; the left hand, which is inserted in the middle of the section, receiving the needle and returning it outwards on the head side of the cord, where it is taken by the right hand, and passed through again on the other side of the cord; thus with all three of the cords, until the needle is brought out at the last left-hand cord or catch-stitch groove, care being taken that the needle never penetrates the cord or twine. The thread is now drawn to the left gently, until only 2 inches or so are left undrawn, at the point where the needle first entered. The first sheet is then laid on, the title-page downwards, and sewn on in the same way, as the needle returns towards the head of the book; when the needle comes out at the catch-stitch mark over the end of thread left undrawn, the sewing thread is tied to that end in a firm knot. Thus all the sheets are sewn in succession, care being taken, on arriving at the catch-stitch, to fasten each sheet to its predecessor by passing the needle round the connecting thread. After he has sewed 4 or 5 sheets, the binder will find his thread exhausted, when he must join on a new length with such a knot as will not be likely to come undone. Several volumes may be sewn on one set of cords, but some attention is necessary that they be not sewn together, and that the cords be long enough for the subsequent purposes.

Cutting.—After sewing, the book is cut from the press, with about 2 inches of the cords protruding on each side.

The back should now receive a coat of glue, and when that is dry, the ends of the cords are untwisted and scraped with a blunt knife till the fibres of the tow are well separated. Now is the time to insert ornamental end-papers, if any are desired; these may be either of marbled or coloured papers; the sheet is folded with the plain side outwards, one-half of it being pasted; it is then laid between the fly-leaves, with the fold of which it is closely worked; the other half is then pasted, and the outside fly-leaf rubbed down upon it. The back of the book has to be rounded, which is done by laying the volume with the fore-edge towards the operator, who, pressing the fingers of his left hand upon it, gently taps the back up and down with a hammer, changing the sides alternately until the back is beaten into a shape somewhat circular. The book is then placed between two backing boards, the thick edges of which are ranged parallel with each other, within about $\frac{1}{8}$ of an inch of the back. The boards and book, being tightly grasped with the left hand, are lowered into the cutting press, until the boards are flush with the cheek of the press, which is then screwed as tightly as possible. The back is hammered gently and uniformly up and down each side, and a little in the middle, which causes it to spread over the boards so as to form the required projection. The book, thus backed, is ready for the covers, which are of millboard, and, being cut to the required size, either with shears or in the cutting press, are pierced with holes pricked with a bodkin, two at each cord, one about $\frac{1}{2}$ inch from the edge, and the second as much beyond it. The frayed cords are then sodden with paste, drawn through the outer side of the board or cover, and passed through the other hole to the outer side again. The book is then held in the left hand, while, with the right, the pasted cords are hammered on a smooth piece of iron, a flat iron screwed into the press will do, into the substance of the millboard covers. It should now be left to dry. The next step is that of cutting the edges, which is rather a difficult process. Hold the book in the left hand, with the fore-edge upwards, and allow the covers to hang down on each side, thrust a paper knife or a flat piece of metal between them and the back of the book. Then placing a cutting board on each side, and opening the covers horizontally, beat the back of the book against the press until it is perfectly flattened. A wedge-shaped cutting board is then placed on the left-hand side of the book, so as to stand with its thick edge considerably higher than the course the knife will take; another board is then placed on the right side, exactly on the line which the knife is to follow, and which line must be previously marked with the point of a pair of compasses, and so measured that the edge when ploughed may fall about the sixth of an inch within the projection of the covers. When the boards are thus placed, the paper knife or flat piece of metal is withdrawn, the covers allowed to hang down, and the volume is thus carefully lowered into the cutting press, until the right-hand board is flush with the cheek, when the press must be screwed tight. The cutting press stands on a hollow frame some 3 feet in depth, which allows of large books being partially lowered into it, and also receives the paper shavings as they are ploughed off. It consists of two wooden cheeks connected by two sliding bars, and two wooden screws. Upon one of the cheeks are two guides, or small raised rails, for the plough to work in. The cutting instrument consists of two sides, connected by a screw with a handle, and by two slide bars. A knife is fastened to the under side of cheek by a strong bolt, which perforates the cheek perpendicularly, and also the circumference of the lateral screw, and is kept tightly in its place by screwing down its nut. The knife is worked by grasping both ends of the lateral screw, moving the plough backwards and forwards, and gradually turning the screw with the right hand, until the whole of the fore-edge is cut through. The book is now taken out of the press, the covers folded in their

place, and the back rounded as before, when the front edge, if the cutting is well done, will be elegantly concave, corresponding with the convexity of the back. The boards, being kept in the ledge or projection produced by backing, are now pulled down about an eighth of an inch from their central position, and the head is ploughed by the knife in the same way as the fore-edge. Before ploughing the opposite end, the boards are pulled below the head as much again as it is intended they shall project; and this end also being ploughed, it will be seen that the projection of the covers is equal on the three sides, or, better still, that it is a little in excess on the fore-edge.

Ornamenting. — After cutting the edges of a book, the next process is to ornament them. This may be done in a simple way by sprinkling them with a brush dipped in a thin solution of umber, or any other colour, ground fine and mixed with size. A more elaborate method is that of marbling the edges, for which purpose a trough must be provided of convenient size and depth, which is filled with pure gum water. Coloured pigments, spirit-ground and mixed with a little ox-gall, are then dripped on the surface of the fluid from a bunch of quills dipped in them — such colours being used as will float and not sink to the bottom. These are then combed with a coarse comb into a neat pattern, and the book being tied between two boards, the edges are applied to the floating colours, which are thus transferred to them. A dash of cold water over them fixes the colours and heightens their brilliancy.

Head-banding.—There are two kinds, stuck on and worked. Head-bands stuck on are formed by cutting a piece of striped linen about an inch deep and as wide as the thickness of the book, folding it over a piece of twine, and gluing it to the back so that the enclosed twine shall in a manner lap over the cut edge, the same being repeated at the opposite end. In well-bound books, however, the head-bands are worked on in the following way;—A strip of string, prepared by rolling it tight in pasted paper, is chosen of a size suited to that of the book; stout silk thread of one or two colours is then taken; if two colours are used, they are doubled and tied together by the ends, one of them being previously threaded in a needle. The book is placed in the cutting press with the back uppermost, the head being elevated towards the workman; the needle is passed through the middle of the second section, on the left-hand side, just below the catch-stitch, and drawn out far enough to bring the knot joining the two silks close into the middle of the section; the needle is then brought up, and passed again through the same place, and the silk drawn nearly close; the round strip is placed in the loop thus formed, and the silk drawn tight with the left hand; the other silk is brought over with the right, and passed under and over the head-band, and held tight with the left hand; the other silk is now put over that, and also under and over the head-band; they are thus worked alternately over each other for about ten sheets or sections; the needle is then passed below the catch-stitch to keep the head-band in its place, and brought over it again, and the work is proceeded with as before; this weaving and frequent fastening to the catch-stitch goes on as far as the last sheet but one, when the needle is passed through the section and over the head-band twice, and fastened to the back. The ends of the head-band are then cut off, almost close to the silk at each end. The braiding produced by working one silk over the other should rest evenly on the leaves of the book. Both ends of the book being worked in this way, the glue-brush is drawn across the back of the bands, which retains them in their proper places. After head-banding the book should receive a hollow back, which is formed by cutting a slip of cartridge-paper twice the width of the back and the same length; fold the paper in half, glue the back, and stick on one of the folded sides, leaving the other doubled upon it.

Casing. — The volume is now ready

for covering with leather, cloth, or leather and paper. For whole-bound volumes the leather is cut nearly an inch larger all round than the open book, and the edges are pared thin with a sharp knife. The inner side of the leather is now well soaked with strong paste, and a small slice being cut from the corners of the covers where they touch the back, the volume is laid on the pasted leather, care being taken that the covers are in the right position, and the two sides are first covered smoothly but not too tightly. The folding over of the pasted leather inside the covers and outside the back, so as to give a handsome appearance to the ends of the volume, is a matter of some difficulty, which, however, a little practice will overcome. It should be done so that the leather in a manner embraces the head-band, which lies half-concealed within it, and yet does not project beyond the proper projection of the covers. After the ends are finished, which operation will be materially assisted by a paper knife having one pointed end, the corners must be attended to; the superfluous leather meeting at the angle must be cut off, the head and foot must be first smoothed down, and then the fore-edge portion folded over them. This requires to be done carefully to look well, and before doing it the binder must see that the covers are lifted over the projecting ledges of the back into the position they ought to occupy. While the leather is soft and moist with the paste, anything may be done with it, and by the help of the folder it may be moulded so as to form a good-looking head. The leather should be pressed in at the corners where the small pieces were taken off the boards, and the folder passed once or twice up and down the hinges of the cover to ensure their opening easily. Lastly, a piece of thread may be tied round the indented corners of the back from end to end, and the whole left to dry. For half-bound books, which are more easily managed, the back and covers are put on separately, the leather being pared in the same way, and small waste bits being used for the corners. When a volume has dried after covering, the ends must be pasted down, and it should remain a little time in the press.

The Finishing Process.—For this purpose provide a book or two of gold leaf, a plain single bookbinder's fillet, a few alphabets of capital letters, a gold-cushion, which can be made by stretching a piece of calf leather rough side upwards over a pad of wadding on a board 10 inches by 8, and some other small items, the use of which will presently appear. First wash the cover with clear paste water, water in which a little paste is dissolved. Such parts as are to be gilded must then be coated twice with glaire or albumen, which is the white of eggs first whipped into froth, and then suffered to subside into a clear liquid. Do not glaire the leather all over, but apply it with a camel-hair pencil and ruler only on the parts where the fillet of gold is to appear. To gild, spread a leaf of gold on the cushion with a knife and blow it flat, then cut it into strips about the sixth of an inch wide. Heat the fillet at the fire until it is just hot enough to fizz under the wet finger; if it sputters it is too hot, and will burn the leather; touch its edge with a rag slightly moistened with sweet oil, and with the same rag rub over the part of the book to be gilt. Roll the fillet softly on the strips of gold, which will adhere to it; when enough is taken up, roll it with a heavier pressure along the glaired lines, and the gold will be indelibly transferred to the leather, what is superfluous being easily wiped away with a soft rag. When the sides of the book are being filleted it may lie on clean paper on the cheeks of the press, or on a pressing board; but when the back is being done it must be screwed in the press in a horizontal position, the back projecting an inch or two.

Substitute for Brass Lettering.—Place an open vessel half-full of water on the fire, and let it boil, and set a small empty tin pot floating within it, loading the pot with some weight that it may sink low in the water. Obtain some ordinary printing types and arrange

them in the required order as a compositor would, in one of those brass frames with wooden handles used for marking linen, and screw them tight in their place, taking care to have them all level with each other on the face. Lay the face of the types in the tin pot, in which some simple contrivance should be placed to prevent their being damaged, and let them get as hot as they will, as in this situation they cannot get too hot. Cut a piece of real morocco leather larger than the size of the label wanted, breathe on it, and give it one coat of glaire; when the glaire is dry rub it slightly over with the oil-rag, and lay on the centre enough leaf gold to receive the impression of the types; place the label on a rather hard pad, and stamp the types on the gold with a sharp even pressure. On wiping off the gold with the rag the impression of the type remains clear and full, and if well done is far more close and distinct than anything which can be done by the most expert finisher with the brass letters of the bookbinder. The label is now cut to the proper size, and pasted evenly in its place on the back of the volume; to look well it should be pared round the edges with a sharp knife until the extreme edge is as thin as paper. After it is dry, a gold fillet may be passed over the juncture of morocco with the calf or other leather by way of finish. The above is the easiest mode of lettering for the amateur, but it is practicable only on real morocco, the heat which can be imparted to printers' metal by hot water not being sufficient to burn the gold into ordinary leather; it is, however, a permanent method.

To Polish the Edges of the Leaves.—Screw the book tight in the press between pressing boards, and rub them briskly with an agate or a dog's tooth. It is important that the press should be tightly screwed, otherwise the leaves will cling together when the operation is over.

To Bind a Book without Tools.—All that need be provided is a little melted glue, some paste, a needle and stout thread, some white and some coloured papers, and a few other trifling items. Arrange the sheets to be bound in their proper order, and beat them even at the back and head, subject them to a heavy pressure between two flat surfaces, by piling weights upon them. If there is a press handy, press them in that, so as to make them lie as close as possible. Now take two pieces of tape ½ an inch wide, and each 2 inches longer than the width of the back of the book. Stiffen the tape by drawing it through paste, and let it dry, with as little of the paste adhering to it as possible, before using. Fold the pieces of stiff tape, and place the sheets within them in such a position that the two tapes will divide the length of the back into three equal parts, or thereabouts. With a lead pencil, while the sheets are pressed down firmly with the left hand, draw a line down each side of the tapes, and two other lines, each one dividing that part of the back outside the tapes into equal portions. These lines mark the place for the entrance of the needle. The sheets of the book are to be sewn on to the tapes in the same way as directed where the book is sewn on to the cords; but with tapes it is not quite so easy, as during the sewing of the first two or three sheets there is some difficulty in keeping the tapes in their places; and as there are no cuts or grooves made with the saw, some force is required to get the needle through the paper. When the book is sewn, the threads fastening each sheet are seen outside the tapes. The back must now receive a coating of glue, not too thin, after which it may be left to dry. The glue being hard and set, the book may be cut on th edges, with a straight-edge and a sharp knife. With a thin volume this is easy enough, but with anything approaching an inch in thickness it will be better to clip any projecting leaves with the shears, and to be content with uncut edges, if a cutting press is not available. The back must next be rounded with the hammer, which may be helped by pulling gently at the tapes while tapping with the tool. For the covers use the thinnest

millboard, or stout pasteboard not thicker than a shilling. Cut two pieces of this of the proper size, so that they shall project about the eighth of an inch over the head, foot, and fore-edge of the book, and glue them in their proper position on the projecting tapes, which will adhere to their inner sides. Over the tapes glue strips of coarse canvas an inch wide by six in length, and now glue on the open back in the manner previously directed. When this glue is dry, the volume may be covered with paper, cloth, leather, or vellum. If vellum is used, that must be lined first with clean white paper firmly pasted on it. A cheap covering is dark roan leather; a still cheaper is coloured canvas; but preferable to that are the leather papers sold by stationers. The mode of pasting on the covers has been already described; but if cloth coverings are used, glue and not paste will be necessary to make them adhere. 2. Instead of gluing the tapes to the boards, cut a cloth cover large enough to allow for overlapping, and, allowing for the width of the back, glue the covers on the cloth parallel with each other, and turn in the cloth round the edges. When this is dry, the book may be placed in the cloth cover, the tapes glued to the inner sides, the open back to the back of cloth, the strengthening canvas also being glued over the tapes; and finally, the end-papers being pasted down, the volume is finished. It will look but a homely affair; but it will cost little beyond the trouble, and will effectually preserve the volume. For many volumes published in numbers, the publishers supply covers at the end of the year: these may be securely fastened on by this simple method.

MARBLING PAPER AND BOOK EDGES.—*Wooden Trough.*—This is made of inch deal, about 1¾ in. in depth and ½ in. in length and breadth larger than the sheets of paper that are to be marbled. This proportion between the size of the trough and paper should always be observed, to prevent waste of colour; of course, troughs of various sizes will be required, where paper of various sizes is to be marbled. The trough must be water-tight, and the edges of the sides of it must be sloped or bevelled off on the outside, to prevent any drops of colour which may fall on them from running into the trough and sullying its contents.

A Skimmer, or clearing stick, must be provided for each trough; this is a piece of wood, 2½ in. wide, ½ in. thick, and as long as the trough it belongs to is wide inside; the use of this will be explained hereafter.

A Stone and Muller of marble, or some other hard stone, the size according to the quantity of colour required to be ground. Also a flexible knife, for gathering the colour together.

A dozen or two of small glazed *pipkins* to hold colours in. The pots being furnished with

Brushes made as follows;—Take a round stick about as thick as your finger, and cut a notch all round one end of it; next, take some bristles, 4 or 5 in. long, and place them evenly round the stick, at the notched end, letting them project 1¾ in. beyond the wood; fasten the bristles to the stick by several turns of stout thread; cut away the ragged bristles, and tie up the brush firmly with fine cord. The use of the notch round the end of the handle is to make the bristles spread out when firmly tied up, so that when used the colour may be scattered about more abundantly.

Rods for drying the paper on when marbled; they should be round, at least on the upper side, and about 1¼ in. in breadth and thickness. Twelve rods 11 ft. long will hang 3½ quires of demy, or 4½ quires of foolscap.

Colours.—Red—vermilion, drop-lake, rose-pink, Venetian red, red ochre. Blue—indigo blue, Prussian blue, verditer. Orange—orange lead, orange orpiment. Black—ivory, blue black. Yellow—Dutch pink, yellow ochre, king's yellow, English pink. The finer the colours are ground, the better and the cheaper will the work be. First, the colours should be finely pounded, then mixed with water to the consistence of paste, and

put in a colour pot with the knife. From the pot, the colour must be taken out a little at a time, and levigated very fine with pure water.

Compound Colours are made by mixing the colours above mentioned in certain proportions. To make a red colour, mix 3 parts of rose-pink with 1 of vermilion. A finer red—4 parts of rose-pink, 2 parts of vermilion, and 1 part of drop-lake; for very fine work use drop-lake alone, but use it very sparingly, for it is a dear article. Yellow—2 parts of Dutch pink, and 1 part each of king's yellow and English pink. Green—made by mixing blue and yellow. Dark blue—indigo, which may be made lighter by the addition of verditer. Orange brown—2 parts of Venetian red, and 1 part of orange lead. A fine orange—put some fine yellow ochre in a ladle over a fire, and keep it there till it assumes a dark-red colour. Take of this red ochre, finely pounded, and of Venetian red, equal quantities, and add a little orange orpiment or rose-pink; mix all well together. Umber colour—equal quantities of Venetian red, orange lead, and ivory black; this can be lightened with orange lead, or darkened with ivory black. Cinnamon colour—Venetian red with a little Prussian blue. All other colours which may be wanted can be made by mixing together those already described. In addition to the articles already mentioned, obtain a bottle of ox-gall, a bottle of good oil of turpentine, some pure water. The trough must be filled to within $\frac{1}{8}$ of an inch of the top, with a solution of gum tragacanth, which is to be prepared as follows;—Gum of a pale white semi-transparent appearance is to be soaked in water for at least 48 hours, in the proportion of $\frac{1}{2}$ lb. to $1\frac{1}{2}$ gallon. Pass the solution of gum through a hair sieve or linen cloth, and pour it into the trough. In all cases, when the trough is to be used, the solution should be well stirred up with a few quills, and the surface of it cleared from film by the skimmer above described.

Colours intended to represent Veins are made by adding a small quantity of gall to the various colours, and stirring each well up with a brush, in order that they may be properly mixed. Previous to use, these mixtures of colour and gall are to be thinned with water to the consistence of cream, and are to be well stirred up.

Colours for producing Spots like Lace-work.—Take some dark blue, or other colour, add some gall to it, and about as much, or a little less, oil of turpentine; stir all well together, and dilute with water. To try the colours, throw on the solution, by shaking the various colour brushes over it, some spots of colour. If the spots spread out larger than a crown-piece in size, the colours have too much gall; if the spots, after spreading out a little, contract again, there is too little gall in them. In the one case more colour must be added, in the other more gall. If the colours are in good order, and paper is to be marbled, the whole surface of the solution in the trough must be covered by colours, in spots, streaks, or whirls, according to the pattern required, and laid on according to directions which will be given presently. The paper should be previously prepared for receiving the colours, by dipping it overnight in water, and laying the sheets on each other with a weight over them. The sheet of paper must be held by two corners, and laid in the most gentle and even manner on the solution covered with the colours, and there softly pressed with the hand that it may bear everywhere on the solution, taking care not to let the colours flow on to the back of the paper any more than can be avoided; after which it must be raised and taken off with the same care, and then hung to dry over the rods.

Patterns.—1. Throw on red till the solution is nearly covered, then some yellow, black, and green; add, if desired, a little purple with plenty of gall and water in it; twist the colours into any shape by means of a quill. 2. Throw on red, yellow, black, and green, as before; but, for a last colour add some of the dark blue mixed with turpentine. 3. Throw on red, yellow

black, and green, in the desired proportion; then with a quill draw lines through the colours; after which throw on a greater or less quantity of blue, green, pink, or purple, much diluted, and containing plenty of gall and turpentine. 4. Throw on very fine red for veins; then plenty of the turpentine blue. If the colours are good this produces a handsome pattern in a short time. 5. Throw on some dark blue mixed with turpentine, and take this up with a paper previously stained of a yellow, light blue, red, pink, or green colour. To obtain a good green for this purpose, boil French berries in water, add a little spirit or liquid blue, and carefully brush over the paper, which must be good and well sized, with this mixture. When the colours become too thick for use, add fresh ground colour with water and a little gall to them, and stir them up well. Be particular in getting good turpentine. When the solution of gum gets dirtied, throw it away and make a fresh one. The neatest and most convenient method of marbling the edges of books, is to dip one volume at a time, doing the ends first, and throwing back the boards to do the fore-edge; observing to hold the book tight with both hands, and not to dip deeper than the surface, to prevent the solution from spoiling the book. It is the safest way to tie the book between boards before dipping; and, for the sake of convenience and economy, when only a few books are to be marbled, a small trough should be used. Marbled paper is glazed by a machine similar to that with which cottons are glazed. But a machine of this kind would only be required by those who marble very largely. Book edges are polished by the agate burnisher, and so might small pieces of paper be polished, which were required for any particular purpose. Good common pressing, or hot-pressing, might serve as well as glazing. For any fancy work it would have a fine effect to varnish the marble paper after it had been put to its destined purpose and had become dry. Paste and all moisture chase all the glaze away. The application of a coat of varnish subsequent to the application of paste would double the beauty of the best marble paper, and much improve the common kind, at a trifling expense.

Sprinkling the Edges of Books.—Take an old toothbrush and dip it into a coloured ink; shake off the superfluous ink, that the sparks formed may not be too large, and draw an old comb through it in such a manner as to make the ink fly off in sparks over the edges of the book. The following are a few coloured inks;—Red; $\frac{1}{4}$ lb. of the best logwood is boiled with 1 oz. of pounded alum, and the same quantity of cream of tartar, with half the quantity of water, and, while the preparation is still warm, 1 oz. sugar and 1 oz. gum arabic are dissolved in it. Blue; solution of indigo with pieces of alumina, and mixed with gum, forms a blue ink. Green; this is obtained from verdigris, distilled with vinegar, and mixed with a little gum. Yellow; saffron, alum, and gum water, form a yellow.

Polishing Metals.—The polishing of metals differs according to their kind, but there are some general principles common to all, of which it may be useful to have a clear idea. All polishing is begun in the first instance by rubbing down the surface by some hard substance that will produce a number of scratches in all directions, the level of which is nearly the same, and which obliterate the marks of the file, scraper, or turning tool that has been first employed. For this purpose coarse emery is used, or pumice and water, or sand and water, applied upon a piece of soft wood, or of felt, skin, or similar material. When the first coarse marks have been thus removed, next proceed to remove the marks left by the pumice-stone by finely-powdered pumice-stone ground up with olive oil, or by finer emery and oil. In some cases certain polishing stones are employed, as a kind of hard slate used with water. To proceed with the polishing, still finer powders are used, such as tripoli and rotten-stone. Putty of tin and crocus martis are also used for high degrees of polish.

But the whole process consists merely in removing coarse scratches by substituting those which are finer and finer, until they are no longer visible to the naked eye; and even long after that, if the surface is examined by a microscope, it will be seen that what appeared without any scratches is covered all over with an infinity of them, but so minute that they require a high magnifier to be discovered. It is evident that great care must be taken to have the last polishing material uniformly fine, for a single grain or two of any coarse substance mixed with it will produce some visible scratches instead of a perfectly polished surface.

Polishing Bar Iron and Steel.—Take an ordinary bar of malleable iron in its usual merchantable state, remove the oxide from its surface by the application of diluted sulphuric acid, after which wash the bar in an alkaline solution, then cover the entire bar with oil or petroleum. The bar is then ready for the chief process. A muffle furnace is so prepared that a uniform, or nearly uniform, heat can be maintained within it, and in this furnace the bar is placed. Care must be taken that too great a heat is not imparted to it, for on this depends the success of the operation. When the bar approaches a red heat, and when the redness is just perceptible, it is a certain indication that the proper degree of heat has been attained. The bar is then at once to be removed, and passed through the finishing rolls five or six times, when it will be found to have a dark polished uniform surface, and the appearance of Russian sheet iron.

Friction Polish.—A good polish for iron or steel rotating in the lathe, is made of fine emery and oil; which is applied by lead or wood grinders, screwed together. Three very good oils for lubrication are olive oil, sperm, and neat's foot.

Polishing Steel.—1. Use bell-metal polishers for arbors, having first brought up the surface with oilstone dust and oil and soft steel polishers; for flat pieces use a piece of glass for the oilstone dust, and a bell-metal block for the sharp red stuff, and a white metal block for the fine red stuff. The polishing stuff must be well mixed up and kept very clean; the polishers and blocks must be filed to clean off the old stuff, and then rubbed over with soft bread; put only a little red stuff on the block and keep working it until it is quite dry, the piece will then leave the block quite clean; use bread to clean off the surplus red stuff before using the brush. If the piece is scratched, put on some more red stuff, which must not be too wet, and try again. 2. The polish on flat steel pieces in fine watchwork is produced with oilstone dust, burnt Turkey stone, and a steel polisher, soft steel, bell-metal, and sharp stuff, grain tin and glossing stuff. The metals are squared with a file, and vary in shape according to the work in hand. 3. Get an 18-gallon barrel and put an iron spindle through the two ends; mount it on trestles in the same way as a butter churn, with a winch to turn it by; cut out a hole in the side by which to introduce the articles to be polished; have a tight-fitting cover to the hole; procure some worn-out casting pots or crucibles, such as used by casters, and pound them in an iron mortar, until fine enough to pass through a sieve which will not allow the steel articles to pass through. Put equal quantities of this grit and of the articles in the barrel; fasten on the cover, and turn the barrel for about an hour, at the rate of about 50 turns a minute; take all out of the barrel and sift out the grit. If a finer polish than this is required, put them through another turning, substituting for the grit small scraps of leather, called mosings, which can be procured from the currier's, and emery flour. Do not more than half fill the barrel.

Brass Polishing. — 1. Brass may be polished without a burnisher, by using an exceedingly fine cut file, and fine emery cloth. 2. Small articles to be polished should be shaken by themselves for a short time; then some greasy parings of leather should be put in the band with them. After they

have been shaken smooth, the greasy leather parings should be removed and clean ones put in, and the shaking continued until the articles are sufficiently bright. 3. When the brass is made smooth by turning or filing with a very fine file, it may be rubbed with a smooth fine-grained stone, or with charcoal and water. When it is made quite smooth and free from scratches it may be polished with rotten-stone and oil, alcohol, or spirits of turpentine.

To Polish German Silver.—Take 1 lb. peroxide of iron, pure, and put half of it into a wash-basin, pouring on water, and keeping it stirred until the basin is nearly full. While the water and crocus is in slow motion, pour off, leaving grit at the bottom. Repeat this a second time, pouring off with another basin. Cleanse out grit, and do the same with the other half. When the second lot is poured off, the crocus in the first will have settled to the bottom; pour off the water gently, take out the powder, and dry it, and put both when washed clear of grit, and dried, into a box into which dust cannot get. If the silver work is very dirty, rub the mixture of powder and oil on with the fingers, and then it will be known if any grit is on the work. If the work is not very black, take a piece of soft chamois leather, and rub some dry crocus on, and when well rubbed, shake out the leather, and let the powder fall off that is not used, or rub it off with a brush. Do not put down the leather in the dust.

Polishing Wheels.—*Emery Wheels.*—1. Can be made with shellac powdered fine, and a small portion of rosin, a piece about the size of a walnut to an ounce of shellac, and a piece of old vulcanized india-rubber about the same size, which gives it toughness. Shellac about 1 oz. to 1 lb. of emery, well melt, and stir about in a small frying pan; well mix the powders before applying heat. Be careful not to burn it, or get grease in it; have a ring of iron and a piece of plate iron prepared with black-lead and beer pretty thick; place the ring upon the plate and make a mould, turn the stuff into it, and well ram down evenly; put on one side to cool; when cold, turn out and chuck in lathe, and with a piece of red-hot iron bore a hole for spindle; after spindled put between centres, and trice-up with hot iron. Very good grindstones may be made with silver-sand mixed with powdered glass, and it is necessary to have some body besides shellac for coarse emery to form a body to bed the grains in. Emery dust from grinding glass, and Turkey stone slips, and slate, may be used as a substitute for the flour. 2. The best emery wheels are formed of clean emery compounded with just a sufficient amount of boiled linseed oil, the mixture being agitated for a sufficient period under exposure to a considerable temperature and a free access of atmospheric air, or some still more powerful oxidizing agent; it assumes the necessary degree of tenacity, and whilst warm, being exposed to hydraulic pressure in a suitable mould, and subsequent drying in a stove, the emery wheel is complete.

Artificial Grindstone.—Washed silicious sand 3 parts, shellac 1 part; melt the lac, and mould in the sand, while warm. Emery may be substituted for sand. Used for razors and fine cutlery.

Making Glaze Wheels for Finishing Steel.—For hollow finishing the following wheels are required;—A mahogany wheel for rough glazing. A mahogany wheel for smooth glazing. A lead wheel, or lap. For flat finishing: A buff wheel for rough. A buff wheel for smooth. A buff wheel for finishing. Lastly, a polisher. To make the glaze wheels: Get the spindles, and point them on each end; then get a block of beech and wedge it on the steel at one end with iron wedges, and turn it for the pulley for the band to run on. Take two pieces of flat mahogany and glue and screw them together, so that the grain of one piece crosses the other, to prevent warping. Let it get thoroughly dry, and wedge it on the spindle and turn it true. The lead wheel is made the same way but made wider, and a groove turned in

the edge. Then the wheel is put into sand, and a ring of lead run round the edge; it is then turned true. To make the buff wheels, proceed as with the glaze; but to save expense, pine or deal wood will do as well as mahogany, only leave it about double the width of the glaze, which is about ½ inch wide, by 12 inches or 14 inches across. The buff wheels are covered with glue, and then the leather is tacked on, with tacks driven in about half-way, so that they may be easily drawn out again. The leather is then turned true. The polisher is made the same way, but the size of the polisher must be a little less than any of the other wheels, say, about an inch. The buff wheels are dressed by laying on a fine thin coat of clear glue, and rolling them round — No. 1, in superfine corn emery; No. 2, in smooth emery; No. 3, by making a cake of equal parts of mutton suet, beeswax, and washed emery; then it is held on the wheel while it is going round. The glaze wheels are dressed while using, by mixing a little of the emery with oil, and putting it on the wheel with a stick or the finger. The leather of the polisher is not covered with glue, but dressed with a mixture of crocus and water, not oil. Care must be taken to keep each wheel and substance to themselves, and the work must be carefully wiped after each operation, and cleanliness must be studied above all things in using the polisher, as the slighest grease getting on it stops the polishing.

Polishing Materials.—*Rouge.*—The rouge used by machinists, watchmakers, and jewellers is a mineral substance. In its preparation crystals of sulphate of iron, commonly known as copperas, are heated in iron pots, by which the sulphuric acid is expelled and the oxide of iron remains. Those portions least calcined, when ground, are used for polishing gold and silver. These are of a bright crimson colour. The darker and more calcined portions are known as crocus, and are used for polishing brass and steel. For the finishing process of the specula of telescopes, usually made of iron or of steel, crocus is invaluable; it gives a splendid polish. Others prefer for the production of rouge the peroxide of iron precipitated by ammonia from a dilute solution of sulphate of iron, which is washed, compressed until dry, then exposed to a low red heat and ground to powder.

Crocus.—Put tin, as pure as possible, into a glass vessel — a wineglass does very well when making small quantities —and pour in sufficient nitric acid to cover it. Great heat is evolved, and care must be taken not to inhale the fumes, as they are poisonous. When there is nothing left but a white powder, it should be heated in a Hessian crucible, to drive off the nitric acid. Crocus, mixed with a little linseed oil, makes a hard and useful cement.

Powders for Cleaning Plate.—1. Take equal parts of precipitated subcarbonate of iron, and prepared chalk. 2. An impalpable rouge may be prepared by calcinating the oxalate of iron. 3. Take quicksilver with chalk, ½ an oz., and prepared chalk 2 oz., mix them. When used, add a small quantity of spirit of wine, and rub with chamois leather; or, put sulphate of iron into a large tobacco pipe, and place it in a fire for a quarter of an hour, mix with a small quantity of powdered chalk. This powder should be used dry.

Jewellers' Rouge.—A rouge suitable for fine work may be made by decomposing a solution of sulphate of iron with oxalic acid also in solution; a precipitate of oxalate of iron falls, which must be well washed and dried; when gently heated, the salt takes fire, leaving an impalpable powder of oxide of iron.

Putty Powder or Oxide of Tin.—Metallic tin is dissolved in nitro-muriatic acid, and precipitated from the filtered solution by liquid ammonia, both fluids being largely diluted with water. The peroxide of tin is then washed in abundance of water. Collect in a cloth filter, and squeeze as dry as possible in a piece of new linen. The mass is now subjected to pressure in a screw press, or between two lever boards, to make it as dry as possible. When the lump thus produced has been broken, it is placed in

a crucible, and closely covered up to prevent jets from entering, and is then exposed and heated to a white heat, and ground for use in the usual way; this oxide is used specially for cements, and polishing astronomical object-glasses for astro-telescopes. The putty powder of commerce, if of good fair quality, is alloyed with about equal parts of tin and lead, which answers for ordinary purposes, but not for polishing lenses, in which good work is wholly dependent on the quality of the powder.

Razor Paste.—Mix fine emery intimately with fat and wax until the proper consistency is obtained in the paste, and then rub it well into the leather strap. Prepare the emery by pounding thoroughly in a mortar the coarse kind, throwing it into a large jug of water and stirring well. Immediately the large particles have sunk, pour off into a shallow plate or basin, and let the water evaporate. This emery is better for engraving and other purposes than that prepared at the emery mills. 2. The grit from a fine grindstone is very efficient for a razor paste. 3. Levigated oxide of tin, prepared putty powder, 1 oz.; powdered oxalic acid, $\frac{1}{4}$ oz.; powdered gum, 20 grains; make into a stiff paste with water, and evenly and thinly spread it over the strop. With very little friction, this paste gives a fine edge to the razor, and its efficiency is still further increased by moistening it. 4. Emery reduced to an impalpable powder, 2 parts; spermaceti ointment, 1 part; mix together, and rub it over the strop. 5. Jewellers' rouge, black-lead, and suet, equal parts; mix.

Cutting Pebbles.—The lapidary's bench is formed with a fly-wheel working horizontally, by hand-crank, with a leather strap passing over and communicating motion to a pulley and spindle, on which as wanted for use are successively fastened the following plates;—1st, the sliding plate of soft iron, very thin, turned up to run quite true on its spindle, the edge dressed with diamond powdered in a hardened steel mortar, and lubricated with oil of brick; turpentine or paraffin is also occasionally used. The stone is held in the hand. The stone is to be reversed after some progress in the cut, to avoid dishing. The cut being completed, the grinding is performed by substituting the second plate of pewter, dressed with coarse emery and water; 3rd ditto, with fine emery and water; 4th, wooden plate, with sand and water; 5th, pewter plate, with rotten-stone and water; 6th, wood plate, covered with leather dressed with putty powder or tripoli, and slightly watered. There may be other plates or discs, but the object to be attained is having a succession of grindings, so that each succeeding plate shall remove the imperfections of polish left by its predecessor.

Polishing Vulcanite.—1. Remove scratches with a smooth wet water of Ayr stone, and then polish in the lathe with fine pumice and a stiff brush. After washing the pumice off, polish it with whiting and soft brush. 2. The mathematical instrument makers treat it as brass—that is, for flat work they first use water of Ayr stone, and then rotten-stone and oil. Turned work is polished in the lathe with rotten-stone and oil, taking care not to use too high a speed, which would heat the work. Some use lampblack and oil to finish with where a very high polish is wanted, or the bare palm of the hand, as in getting up silver plate. Chain and ornament makers use circular buffs for their flat work, made of sea-horse leather, and for work of irregular forms, buffs of calico. A number of pieces, 12 in. in diameter, are screwed together between flanges, like a circular-saw spindle, and used with rotten-stone, always taking care not to heat the work; brushes are not at all suitable for it.

Polishing Plaster Casts.—1. Put into 4 lbs. of clear water 1 oz. of pure curd soap, grated and dissolved in a well-glazed earthen vessel—then add 1 oz. of white beeswax, cut into thin slices; when the whole is incorporated it is fit for use. Having well dried the figure before the fire, suspend it by a twine, and dip it once in the varnish; upon taking it out, the moisture will appear to have been absorbed in 2 minutes'

time; stir the compost, and dip the figure a second time; this generally suffices. Cover it carefully from the dust for a week; then, with soft muslin rag, or cotton wool, rub the figure gently, when a most brilliant gloss will be produced. 2. Take skimmed milk, and with a camel-hair pencil lay over the model till it will imbibe no more. Shake or blow off any that remains on the surface, and lay the figure in a place perfectly free from dust; when dry it will look like polished marble. If the milk is not carefully skimmed it will not answer the purpose. 3. Fuse ½ oz. of tin, with the same quantity of bismuth, in a crucible; when melted, add ½ oz. of mercury; when perfectly combined, take the mixture from the fire and cool it. This substance, mixed with the white of an egg, forms a beautiful varnish for plaster-of-Paris casts. 4. Of stearine and Venetian soap each 2 parts; pearlash, 1; the stearine and soap cut small and mixed with 30 parts of solution of caustic potash, boiled for half an hour, stirring continually. Add the pearlash dissolved in a little rain water and boil a few minutes; stir until cold, and mix with more ley until it is quite liquid; keep well covered up. Remove all dust and stains from the plaster, and apply the wash as long as it is absorbed. When dry, rub with a soft leather or brush. Should the surface not shine, apply another coat. This composition may be preserved for years. 5. Coat with melted white wax, and place them before a fire until the wax is absorbed; a considerable polish can then be obtained by friction. 6. First make very smooth and free from grit with glass-paper or otherwise; oil with linseed oil; when dry, French polish in the usual way. If a bust, or anything similar, required to be white, make smooth size with white size, and varnish with white hard varnish.

Polishing Slate.—Slate is faced first with an iron plate with river sand and water, smoothed with pumice-stone; then japanned and baked to harden the japan, and again smoothed with pumice-stone and polished with rotten-stone.

Polishing Shells. — 1. Marine shells are cleaned by rubbing with a rag dipped in common hydrochloric acid till the outer dull skin is removed, washing in warm water, drying in hot saw-dust, and polishing with chamois leather. Those shells which have no natural polished surface may either be varnished or rubbed with a little tripoli powder and turpentine on wash-leather, then fine tripoli alone, and lastly with a little fine olive oil, bringing up the surface with the chamois as before. 2. The shells are first boiled in a strong solution of potash, then ground on wheels, sometimes through one strata to show an underlying one, then polished with hydrochloric acid and putty powder. In this operation the hands are in great danger. Shell grinders are generally almost cripples in their hands.

Polishing Mother-of-Pearl.—Go over it with pumice-stone finely powdered, washed to separate the impurities and dirt, with which polish it very smooth; then apply putty powder and water by a rubber, which will produce a fine gloss and good colour.

Polishing Horn and Ivory.—Ivory and bone admit of being turned very smooth, or when filed may afterwards be scraped so as to present a good surface. They may be polished by rubbing first with fine glass-paper, and then with a piece of wet linen cloth dipped in powdered pumice-stone. This will give a very fine surface, and the final polish may be produced by washed chalk or fine whiting applied by a piece of cloth wetted with soapsuds. Care must be taken in this, and in every instance where articles of different fineness are used, that, previous to applying a finer, every particle of the coarser material is removed, and that the rags are clean and free from grit. Ornamental work must be polished with the same materials as plain work, using brushes instead of linen, and rubbing as little as possible, otherwise the more prominent parts will be injured. The polishing material should be washed off with clean water, and when dry, may be rubbed with a clean brush. Horn and

tortoiseshell are so similar in their nature and texture that they may be classed together. As regards the general mode of working and polishing them, a very perfect surface is given by scraping. The scraper may be made of a razor-blade, the edge of which should be rubbed upon an oilstone, holding the blade nearly upright, so as to form an edge like that of a currier's knife, which may be sharpened by burnishing. Work when properly scraped is prepared for polishing. To effect this it is first rubbed with a buff made of woollen cloth perfectly free from grease. The cloth may be fixed upon a stick to be used by hand; but a bob, which is a wheel running in the lathe and covered with the cloth, is much to be preferred on account of the rapidity of motion. The buff may be covered either with powdered charcoal and water, or fine brick-dust and water. After the work has been made as smooth as possible with this, it is followed by another bob on which washed chalk or dry whiting is rubbed. The article to be polished is slightly moistened with vinegar, and the buff and whiting will produce a fine gloss, which may be completed by rubbing with the palm of the hand and a small portion of dry whiting or rotten-stone.

Polishing Bullocks' Horns.—1. Well scrape with glass or steel scraper, afterwards with finest glass-cloth, then with powdered bath brick and oil, and finally with rotten-stone and flannel, or old cloth or felt hat. 2. First scrape with glass to take off any roughness, then grind some pumice-stone to powder, and with a piece of cloth wetted and dipped in the powder, rub them until a smooth face is obtained. Next polish with rotten-stone and linseed oil, and finish with dry flour and a piece of clean linen rag. The more rubbing with the stone and oil, the better the polish. Trent sand is used in the Sheffield factories. It is a very fine and sharp sand, and is prepared for use by calcining and sifting.

Polish for Leather. — ½ lb. treacle, 1 oz. lampblack, a spoonful of yeast, 1 oz. sugar-candy, 1 oz. sweet oil, 1 oz. gum dragon, 1 oz. isinglass, and a cow's gall. Mix well in 2 pints of stale beer. Warm the mixture, and apply with a sponge. It will then produce a softness of the leather, and a high brilliancy of polish.

Burnishing.—To burnish an article is to polish it, by removing the small roughness upon its surface; and this is performed by a burnisher. This mode of polishing is the most expeditious, and gives the greatest lustre to a polished body. It removes the marks left by the emery, putty of tin, or other polishing materials; and gives to the burnished articles a black lustre, resembling that of looking-glass. The form and construction of the burnisher is extremely variable, according to the respective trades; and it must be adapted to the various kinds of work in the same art. In general, as this tool is only intended to efface inequalities, whatever substance the burnisher is made of is of little consequence to the article burnished, provided only that it is of a harder substance than that article.

To Burnish Silver. — Commence by cleaning off any kind of dirt which the surfaces of the silver articles had contracted whilst making, as that would entirely spoil the burnishing. For this purpose take pumice-stone powder, and with a brush, made very wet in strong soapsuds, rub the various parts of the work, even those parts which are to remain dull, which, nevertheless, receive thus a beautiful white appearance; wipe with an old linen cloth, and proceed to the burnishing.

Burnishers.—The burnishers used are of two kinds, of steel and of hard stone. They are either curved or straight, rounded or pointed, and made so as to suit the projecting parts, or the hollows of the piece. Stone burnishers are made of blood-stone, cut, and either rounded with the grindstone, or rubbed, so that they present, at the bottom, a very blunt edge, or sometimes a rounded surface. These are polished with emery, like steel burnishers, and are finished by being rubbed upon a leather, covered with crocus martis. The stone is mounted

in a wooden handle, and firmly fixed by a copper ferrule, which encircles both the stone and the wood. The best blood-stones are those which contain the most iron, and which, when polished, present a steel colour. The operation of burnishing is very simple; take hold of the tool very near to the stone, and lean very hard with it on those parts which are to be burnished, causing it to glide by a backward and forward movement, without taking it off the piece. When it is requisite that the hand should pass over a large surface at once, without losing its point of support on the work-bench, in taking hold of the burnisher be careful to place it just underneath the little finger. By this means the work is done quicker, and the tool is more solidly fixed in the hand. During the whole process, the tool must be continually moistened with black soapsuds. The water with which it is frequently wetted causes it to glide more easily over the work, prevents it from heating, and facilitates its action. The black soap, containing more alkali than the common soap, acts with greater strength in cleansing off any greasiness which might still remain on the surface; it also more readily detaches the spots which would spoil the beauty of the burnishing. In consequence of the friction the burnisher soon loses its bite, and slips over the surface of the article as if it were oily. In order to restore its action, it must be rubbed, from time to time, on the leather. The leather is fixed on a piece of hard wood, with shallow furrows along it. There are generally two leathers—one made of sole leather and the other of buff leather. The first is impregnated with a little oil and crocus martis, and is particularly used for the blood-stone burnishers; the other has only a little putty of tin scattered in the furrows, and is intended exclusively for rubbing steel burnishers, as they are not so hard as the blood-stones. Blood-stone being very hard, the workman uses it whenever he can, in preference to the steel burnisher. It is only in small articles, and in difficult places, that steel burnishers are used; as they, by their variety of form, are adapted to all kinds of work. In general, the blood-stone greatly reduces the labour. When the articles, on account of their minuteness, or from any other cause, cannot be conveniently held in the hand, they are fixed in a convenient frame on the bench; but under all circumstances be very careful to manage the burnisher so as to leave untouched those parts of the work which are intended to remain dull. When, in burnishing an article which is plated or lined with silver, there is any place where the layer of precious metal is removed, restore it by silvering these places with a composition supplied by the silverer, which is applied with a brush, rubbing the part well, and wiping it afterwards with an old linen cloth. The burnishing being finished, remove the soapsuds which still adhere to the surface of the work; this is effected by rubbing it with a piece of old linen cloth. But when there are a great number of small pieces to finish, to throw them into soapsuds and dry them afterwards with saw-dust is more expeditious. The burnishing of gold leaf or silver, on wood, is performed with burnishers made of wolves' or dogs' teeth, or agates, mounted in iron or wooden handles. When about to burnish gold, applied on other metals, dip the blood-stone burnisher into vinegar; this kind being exclusively used for that purpose. But when burnishing leaf-gold on prepared surfaces of wood, keep the stone, or tooth, perfectly dry. The burnisher used by leather gilders is a hard polished stone, mounted in a wooden handle—this is to sleek or smooth the leather. The ordinary engravers' burnisher is a blade of steel, made thin at one end, to fit into a small handle to hold it by. The part in the middle of the blade is rounded on the convex side, and is also a little curved. The rounded part must be well polished, and the tool be very hard. This burnisher is used to give the last polish to such parts of copper and steel plates as may have been accidentally scratched, or specked, where false lines are to be removed, and also

to lighten in a small degree such parts as have been too deeply etched or graved. In clockmaking, those pieces or parts are burnished which, on account of their size or form, cannot be conveniently polished. The burnishers are of various forms and sizes; they are all made of cast steel, very hard, and well polished; some are formed like sage-leaf files, others like common files—the first are used to burnish screws, and pieces of brass; the others are used for flat pieces. The clockmakers have also very small ones of this kind, to burnish their pivots—they are called pivot burnishers.

Burnishing Pewter.—The burnishing of pewter articles is done after the work has been turned, or finished off with a scraper—the burnishers are of different kinds, for burnishing articles either by hand, or in the lathe; they are all of steel, and while in use are rubbed with putty powder on leather, and moistened with soapsuds.

Burnishing Cutlery.—The burnishing of cutlery is executed by hand or vice burnishers; they are all made of fine steel, hardened, and well polished. The first kind have nothing particular in their construction; but vice burnishers are formed and mounted in a very different manner. On a long piece of wood, placed horizontally in the vice, is fixed another piece, as long, but bent in the form of a bow, the concavity of which is turned downwards. These two pieces are united at one of their extremities by a pin and a hook, which allows the upper piece to move freely around this point as a centre. The burnisher is fixed in the middle of this bent piece, and it is made more or less projecting, by the greater or lesser length which is given to its base. The movable piece of wood, at the extremity opposite to the hook, is furnished with a handle, which serves the workman as a lever. This position allows the burnisher to rest with greater force against the article to be burnished, which is placed on the fixed piece of wood. The burnisher has either the form of the face of a round-headed hammer, well polished to burnish those pieces which are plain or convex; or the form of two cones opposed at their summits, with their bases rounded, to burnish those pieces which are concave or ring-shaped.

Burnishing Book Edges.—This is done with a wolf's or dog's tooth, or a steel burnisher; for this purpose place the books in a screw press, with boards on each side of them, and other boards distributed between each volume; first rub the edges well with the tooth to give them a lustre. After sprinkling or staining and when the edges are become dry, burnish the front; then turning the press, burnish the edges at the top and bottom of the volume. Burnish the gilt edges in the same manner, after having applied the gold; but observe in gilding, to lay the gold first upon the front, and allow it to dry; and on no account to commence burnishing till it is quite dry.

Black for Blackboard.—1. Paint the board with ordinary black paint such as will dry with a gloss; then apply a coat of black paint, mixed with turps instead of oil, which will dry a dead black. 2. Take ½ lb. of logwood, and sufficient boiling water to cover it; allow it to stand for 24 hours. Strain, and apply the solution, boiling, it possible, twice, allowing the board to dry in the interval. Then dissolve ¼ lb. of copperas in about 1 pint of boiling water, and apply it boiling, once or twice, according to the degree of blackness obtained. Before using it, rub it over well with rushes, straw, ferns, or shoemakers' heel-ball. It may be a little difficult to rub the chalk off at first, but after a fortnight's use that will disappear. Use unprepared chalk, which writes well. 3. Place ¼ lb. of lampblack on a flat piece of tin or iron on a fire till it becomes red, take it off and leave it until sufficiently cool, when it must be crushed with the blade of a knife on a flat board quite fine; then get ½ pint of spirits of turpentine, mix both together, and apply the mixture with a size-brush. If the board is new, it would be well to give it one or two coats of lampblack—not burnt, but mixed with boiled oil—adding ½ lb. ot

patent driers. After the board is thoroughly dried, apply the burnt lampblack and turpentine. The preparation must be laid on quickly.

Printers' Rollers.—1. To 8 lbs. of transparent glue add as much rain or river water as will just cover it, and occasionally stir it during 7 or 8 hours. After standing for 24 hours, and all the water is absorbed, submit it to the action of heat in a water bath, that is, surrounded by water, as glue is generally heated, and the glue will soon be dissolved. Remove it from the fire as soon as froth is seen to rise, and mix with it 7 lbs. of molasses, which has been previously made tolerably hot; stir the composition well together in the water bath over the fire, but without suffering it to boil. After being thus exposed to the heat for half an hour, and frequently well stirred, it should be withdrawn from over the fire and allowed to cool for a short time, previous to pouring it into a cylindrical mould made of tin, tinned sheet iron, or copper, having a wooden cylinder previously supported in its centre by means of its end-pivots or gudgeons. After remaining in the mould at least 8 or 10 hours in winter, and a longer time in summer, the roller is to be taken out of the mould by means of a cord fastened to one of the gudgeons, and passed over a strong pulley fixed to the ceiling; but care must always be taken that the cylinder is drawn out slowly from the mould. Old rollers are recast in the same manner, first taking care to wash them with a strong alkaline ley, and adding a small quantity of water and molasses. The best mode, however, of making use of the old composition, is by mixing it with some new, made of 2 lbs. of glue and 4 lbs. of molasses. 2. Composition for rollers;—Summer use, $1\frac{1}{2}$ lb. best glue and 4 lbs. treacle; winter use, 1 lb. best glue and 4 lbs. treacle. Soak the glue about $1\frac{1}{2}$ hour if thick, if thin 1 hour. Take it out of the water, lay it on a board until next day, then melt down in proper melting pot, or put it in a saucepan and place it in another containing water. Do not let the water run over into the glue; one great secret in roller casting is to have as little water in the glue as possible. Add treacle as above, let boil once, then keep it just under boiling-point until cooked, which takes about 2 hours, more or less; pour out into moulds, well cleaned and greased; if the composition is left too long on the fire it will get thick and spoil. The above is sufficient for an 18-in. roller; other sizes in proportion.

Hints about Screws.—Where screws are driven into soft wood and subjected to considerable strain, they are very likely to work loose, and it is often difficult to make them hold. In such cases the use of glue is profitable. Prepare the glue thick; immerse a stick about half the size of the screw and put it into the hole; then immerse the screw, and drive it home as quickly as possible. When there is an article of furniture to be hastily repaired, and no glue is at hand, bore a hole, insert the stick, fill the rest of the cavity with pulverized rosin, then heat the screw sufficient to melt the rosin as it is driven in. Where screws are driven into wood for temporary purposes, they can be more easily removed by dipping them in oil before inserting. When buying screws, notice that the heads are sound and well cut, that there are no flaws in the body or thread part, and that they have gimlet points. A screw of good make will drive into oak as easily as others into pine, and will endure having twice the force brought against it.

Silkworm Gut for Fishing.—1. Wash the gut in a little soda, steep it in some alum water, take out if wanted brown; use a strong decoction of tea, if black, it can be done with the addition of a little powdered nut-gall in the tea, and passing it through a little vinegar in which some old nails have been; if salmon-coloured, saffron decoction; if properly done it will have very little gloss upon it. 2. Steep some walnut-leaves in a basin of water for a day or two, having previously bruised them. Then soak the gut in it; the longer it is left in, the darker it will be. This will be found quite dark enough for all

ordinary purposes. To dye brown, steep in strong coffee.

Hair for Brushes.—In the manufacture of hair pencils or brushes, the hairs are scoured in a solution of alum till they are free from grease, and then steeped 24 hours in lukewarm water. The water is next squeezed out by pressing them strongly from the root to the tip. They are then dried by pressure with linen cloths, and combed as smooth as possible. Bunches of hair are then placed in small flat-bottomed tin pans, with the tips of the hair upwards; on striking the bottom of the pan the hairs get arranged parallel to each other, and the long hairs standing higher than the others may easily be picked out.

Writing on Slate.—Draw in the letters with a black-lead pencil; if wanted very accurate, go over with a draw-point, then taking a square graver, cut a deep bold line up the centres of the letters; this line, if done with one cut, will be broken and jagged at the edges; then take a flat tool, a tool about $\frac{1}{4}$ of an inch broad, and sharpened exactly the same as a joiner's chisel, but mounted in a graver handle, and with the flat side to the slate, cut from the centre stroke to the outside edge of the letter, holding the tool so as to cut the outside of the letter bevelled; it cuts as clean as a bit of cheese, the letter when finished being deep in the centre and bevelled off on both sides.

Enlarging Woodcuts for Diagrams.—Trace the desired picture on a piece of ground glass, using a sharp and well-pointed lead pencil. Hang up the large paper intended for the diagram, and using the ground glass as a slide in a powerful magic-lantern, project the image on to the paper, regulating the size of the picture by approaching or receding from it. Copy the lines on the paper, and if the operation is carefully performed the picture will be in perfect proportion, and the most intricate figures can thus be easily reproduced.

Veneering. — In veneering with the hammer, cut the veneer a little larger than the surface to be covered, as it slips a little while laying; it is first roughened on both sides with the toothing plane, or a rough rasp; this removes all grease and saw-marks; the surface to be veneered is treated in a similar way. This roughening causes the glue to adhere. They are then well warmed at the fire. Now clear the bench of all encumbrances, save glue-pot, hot water, sponge, and veneering hammer. Wet both sides of the veneer, and apply plenty of glue; lay the veneer down on its bed, whilst an assistant holds one end firm; take the veneering hammer in the right hand, press hard down on the head with the left; begin at the middle, and work zigzag ways towards the end and sides, pressing out all superfluous glue; turn the work round, begin at the middle again, and work off at the other end, going over it several times until it has stuck; keep it damp all the time with the sponge; a slight tap with the back of the hammer will tell if it is firm by the sound; lay a weight on it, and set it to dry near the fire. Veneer is laid in two ways, by cauls, and with the veneering hammer. Both systems are used to about an equal extent, the caul being better suited to some kinds of work, and the hammer to others. An amateur will find it much better to use the caul when practicable, as all that is necessary is to prepare the surface of the article, glue it with thick glue, lay on the veneer, and on that the previously heated caul. The hand-screws are now applied, and the whole left until cold. In laying small pieces with the hammer it is merely necessary to glue one side and damp the other, to keep it from curling, but with large surfaces it is necessary to use a heated flat iron in advance of the hammer, and to do this effectively requires no little practice. The cauls should be either soaped before use, or pieces of paper should be placed between them and the veneer to prevent sticking.

Cauls.—The cauls are made of dry pine wood, and should be free from knots and flaws. They must be made in shape the exact converse of the surface which is to be veneered. If the veneered

surface is flat, the caul is flat also; if convex, the caul must be concave. In order to ensure perfect contact between the caul and the veneer throughout the entire surface, it is found advisable to make the cauls of such a thickness as will allow them to bend slightly under the pressure of the handscrews. They are then shaped to touch only in the middle of the work, when, by screwing the caul and the work together at the edges, a great pressure commences at the centre and spreads in all directions towards the edges, forcing the superfluous glue out in advance.

Veneering Hammer.—Take an ordinary hammer, place the head in the palm of the hand with the handle sticking out forward, place the toe upon a piece of veneer previously glued on the under side, and wriggle the handle backwards and forwards from right to left, at the same time pressing downwards; the superfluous glue will be worked out to the edges, and the veneer will remain sticking to the wood underneath. As the toe of a common hammer is found too narrow in practice, the veneering hammer is substituted, which consists in the simplest form of a flat square of hard wood or iron, with a handle stuck in perpendicularly, and is used in the same manner as described above.

Removing Blisters from Veneer.—First wash the exterior of the blister with boiling water, and with a coarse cloth remove dirt and grease; then place it before the fire, or heat it with a caul; oil its surface with common linseed oil; place it again to the fire, and the heat will make the oil penetrate quite through the veneer and soften the glue underneath, then while hot raise the edge gently with a chisel, and it will separate completely from the ground; be careful not to use too great force or it will spoil the work again. If it should get cold during the operation, apply more oil and heat it again; repeat this process to entirely separate the veneer; then wash off the old glue, and proceed to lay it again as a new veneer.

Dyeing Wood for Veneers.—Dyeing wood is mostly practised for veneers, while staining is generally to give the desired colour to the article after it has been manufactured. In the first case the colour should penetrate throughout, while in the latter a surface colour only is essential. In dyeing, pear-tree, holly, and beech take the best black, but for most colours holly is preferable. It is also best to have the wood as young and as newly cut as possible. After the veneers are cut, they should be allowed to lie in a trough of water for four or five days before placing them into the copper; the water, acting as a purgative to the wood, brings out abundance of slimy matter. After this purifying process they should be dried in the open air for at least 12 hours; they are then ready for the copper. By these simple means the colour will strike much quicker, and be of a brighter hue. It would also add to the improvement of the colours, if, after the veneers have boiled a few hours, they are taken out, dried in the air, and again immersed in the colouring copper. Always dry veneers in the open air; for fire invariably injures the colours.

Fine Black.—1. Put 6 lbs. of chip logwood into the copper, with as many veneers as it will conveniently hold, without pressing too tight; fill it with water, and boil slowly for about three hours; then add ½ lb. of powdered verdigris, ½ lb. of copperas, and 4 oz. of bruised nut-galls; fill the copper up with boiling vinegar as the water evaporates; let it boil gently two hours each day, till the wood is dyed through. 2. Procure some liquor from a tanner's pit, or make a strong decoction of oak bark, and to every gallon of the liquor add ¼ lb. of green copperas, and mix them well together; put the liquor into the copper, and make it quite hot, but not to boil; immerse the veneers in it, and let them remain for an hour; take them out, and expose them to the air till it has penetrated its substance; then add some logwood to the solution, place the veneers again in it, and let it simmer for two or three hours; let the whole cool gradually, dry the veneers in the shade. 3. A good black stain for immediate

use. Boil ½ lb. of chip logwood in 2 quarts of water, add 1 oz. of pearlash, and apply hot with a brush. Then take a similar decoction of logwood, and to it add ½ oz. of verdigris and ½ oz. of copperas; strain well, add ½ lb. of rusty steel filings, and apply.

Blue.—1. Into a clean glass bottle put 1 lb. of oil of vitriol, and 4 oz. of the best indigo pounded in a mortar; set the bottle in a basin or earthen glazed pan, as it will ferment; now put the veneers into a copper, or stone trough; fill it rather more than ⅓rd with water, and add as much of the vitriol and indigo, stirring it about, as will make a fine blue; let the veneers remain till the dye has struck through. The colour will be much improved if the solution of indigo in vitriol is kept a few weeks before using.

Yellow.—Reduce 4 lbs. of the root of barberry, by sawing, to dust, which put in a copper or brass trough; add 4 oz. of turmeric, and 4 gallons of water, then put in as many white holly veneers as the liquor will cover; boil them together for 3 hours, often turning them; when cool, add 2 oz. of aquafortis, and the dye will strike through much sooner.

Bright Yellow.—To every gallon of water necessary add 1 lb. of French berries; boil the veneers till the colour has penetrated through; add the following liquid to the infusion of the French berries, and let the veneers remain for 2 or 3 hours, and the colour will be very bright.

Liquid for Brightening and Setting Colours.—To every pint of strong aquafortis add 1 oz. of grain tin, and a piece of sal ammoniac of the size of a walnut; set it by to dissolve, shake the bottle round with the cork out, from time to time; in the course of 2 or 3 days it will be fit for use. This is an admirable liquid to add to any colour, as it not only brightens it, but renders it less likely to fade from exposure to the air.

Bright Green.—1. Proceed as in either of the above receipts to produce a yellow; instead of adding aquafortis or the brightening liquid, add as much sulphate of indigo as will produce the desired colour. 2. Dissolve 4 oz. of the best verdigris, and sap-green and indigo ½ oz. each, in 3 pints of the best vinegar; put in the veneers, and gently boil till the colour has penetrated sufficiently. The hue of the green may be varied by altering the proportion of the ingredients; and unless wanted for a particular purpose, leave out the sap-green, as it is a vegetable colour very apt to change, or turn brown, when exposed to the air.

Bright Red.—1. To 2 lbs. of genuine Brazil dust add 4 gallons of water; put in as many veneers as the liquor will cover; boil them for 3 hours; then add 2 oz. of alum, and 2 oz. of aquafortis, and keep it lukewarm until it has struck through. 2. To every pound of logwood chips add 2 gallons of water; put in the veneers, and boil as in the last, then add a sufficient quantity of the brightening liquid; keep the whole warm till the colour has sufficiently penetrated. The logwood chips should be picked from all foreign substances, with which it generally abounds, as bark and dirt; it is always best when fresh cut, which may be known by its appearing of a bright-red colour; if stale it will look brown, and will not yield so much colouring matter.

Purple.—1. To 2 lbs. of chip logwood and ½ lb. of Brazil dust add 4 gallons of water, and after putting in the veneers, boil them for at least 3 hours; then add 6 oz. of pearlash and 2 oz. of alum; let them boil for 2 or 3 hours every day, till the colour has struck through. The Brazil dust is to make the purple of a red cast; it may, therefore, be omitted, if a deep blueish purple is required. 2. Boil 2 lbs. of logwood, either in chips or powder, in 4 gallons of water with the veneers; after boiling till the colour is well struck in, add by degrees sulphate of indigo, till the purple is of the shade required, which may be known by trying it with a piece of paper; let it then boil for 1 hour, and keep the liquid in a milk-warm state till the colour has penetrated the

veneer. This method, when properly managed, will produce a brilliant purple, not so likely to fade as the foregoing.

Orange.—Let the veneers be dyed, by either of the methods previously given, of a fine deep yellow, and whilst they are still wet and saturated with the dye, transfer them to the bright-red dye till the colour penetrates equally throughout.

Silver Grey.—1. Expose to the weather in a cast-iron pot of 6 or 8 gallons, old iron nails, hoops, or other scraps, till covered with rust; add 1 gallon of vinegar and 2 of water, boil all well for an hour; have the veneers ready, which must be air-wood, not too dry; put them in the copper used to dye black, and pour the iron liquor over them; add 1 lb. of chip logwood, and 2 oz. of bruised nut-galls; then boil up another pot of the iron liquor to supply the copper with, keeping the veneers covered, and boiling two hours a day, till of the required colour. 2. Expose any quantity of old iron in any convenient vessel, and from time to time sprinkle them with spirits of salt, diluted in four times its quantity of water, till they are very thickly covered with rust; then to every 6 lbs. add a gallon of water, in which has been dissolved 2 oz. of salts of tartar; lay the veneers in the copper, and cover them with this liquid; let it boil for two or 3 hours till well soaked, then to every gallon of liquor add $\frac{1}{4}$ lb. of green copperas, and keep the whole at a moderate temperature till the dye has sufficiently penetrated.

Staining Woods.—Staining wood is quite a different process to dyeing it, and requires no previous preparation of the wood. There is little trouble in preparing the stain, and its application differs but slightly from painting. Staining is divided into washing, matching, imitating, painting, and improving.

Washing consists in coating common white deal or fir with a dilute aqueous solution of clear glue, suitably tinted with a proper combination of two or more colours, such as 1 part red-lead, or Venetian red, with 2 parts yellow-lead, chrome or ochre, for a mahogany colour; equal parts of burnt umber and brown ochre for the antique hues of old wainscot oak; Venetian red, tinted with lampblack, for the shades of rosewood; ivory black for ebony; whiting, or white-lead, tinted with orange chrome, for the tones of white-yellowish woods; burnt umber, modified with yellow ochre, for walnut, and so on. Wash colour should always be applied in a warm state by a flannel, and the coloured wood ought to be evenly wiped dry with shavings or rags.

Matching is to bring different pieces of timber, in an article of furniture, to a responsive tone of colour, so that they may represent the appearance of one entire piece. First bleach the darkest parts, by carefully coating them with a strong solution of oxalic acid in hot water, to which is added a few drops of spirits of nitre. When the blanched parts become dry, coat them two or three times with white polish by means of a camel-pencil. This process does not always prove satisfactory, in which case lay on a delicate coat of white stain, and another of white varnish; then give the intermediate dark parts a coat of common varnish, and proceed to oil all the untouched white portions; next compare the whole, and when the white pieces happen to be much lighter than the dark ones, colour them the exact hue by coating them with a darkening stain.

Darkeners.—The darkeners in general use are logwood, lime, brown soft soap, dyed oil, aquafortis, sulphate of iron, nitrate of silver, with exposure to the sun's rays, carbonate of soda, bichromate and permanganate of potash, and other preparations of an acidulous or alkaline nature. Of these the latter three are the most preferable. Procure 1 oz. of one of these alkalies, powder, and dissolve in 2 gills of boiling water; next get 3 bottles, label them 1, 2, 3, or weak, medium, and strong; put $\frac{1}{2}$ of the solution into No. 3, and $\frac{1}{2}$ gill into No. 2, and the same into No. 1; then pour an additional gill of clean water into No. 2, and 2 gills of the same into No. 1. By separately dissolving both

alkalies in the manner described, six liquids are obtained capable of staining nearly all casts of wood of a complete series of brown and dark tints. The solutions of carbonate are generally used for dark materials, like rosewood, and those of the bichromate are applicable to all the intermediate and white woods, such as mahogany, oak, and beech. The safest way to use these alkaline fluids is to pour a sufficient quantity into a saucer, into which dip a sponge or a flannel, in order to saturate it thoroughly, then with it rub evenly over the timber, and instantly dry off the stained surface with a handful of rags or other soft waste; to ensure success, follow out this manipulation with great care and the utmost dispatch. When the dark and light portions are neither very black nor very white, varnish the former, and allow the latter to stand in oil for a time.

Improving.—An aqueous decoction of barberry root, or an alcoholic solution of gamboge or turmeric, will, if properly applied, impart a delicate yellow hue. Oily decoctions of alkanet-root, and alcoholic solutions of dragon's-blood, yield rich mild reds. Rectified naphtha that has been dyed with camwood dust serves for another reddening tincture. Lightish hard wood, such as birch, is frequently improved in colour by being sponged with oil that is slightly tinted with rose madder, or Venetian red. A solution of asphaltum in spirits of turpentine makes a brown stain for coarse oaken work, which is only intended to be varnished with boiled oil. When discoloured ebony has been sponged once or twice with a strong decoction of gall-nuts, to which a quantity of steel dust has been added, its natural blackness becomes much more intense. The naturally pale ground and obscure grain of Honduras mahogany is often well brought out by its being coated first with spirit of hartshorn and then with red oil. Greyish maple may be whitened by the process already described in matching. Half a gallon of water, in which ½ lb. of oak bark and the same quantity of walnut shells or peels have been thoroughly boiled, makes an excellent improver of poor rosewood; it is also far before any other of its kind for bringing out to perfection the veiny figures and ground shades of walnut. Raw oil, mixed with a little spirits of turpentine, is the most efficacious improver of a great number of materials. Beautiful artificial graining may be imparted to various specimens of timber, by means of a camel-pencil, with raw oil alone; that is, certain portions may be coated two or three times, so as to resemble the rich varying veins which constitute the fibril figures; while the common ground shades may only be once coated with the oil very much diluted with spirits of turpentine.

To Improve the Colour of any Stain.—Mix in a bottle 1 oz. of nitric acid, ½ teaspoonful of muriatic acid, ½ oz. of grain tin, and 2 oz. of rain water. Mix it at least 2 days before using, and keep the bottle well corked.

Directions for Staining.—In preparing any of the tinctures, it is of importance to powder or mash all the dry stuffs previous to dissolving or macerating them, and to purify all the liquids by filtration before use. Their colouring powers, which mainly depend on very accurate combinations of the requisite ingredients, should always be carefully tested before a free use is made of them, and the absorbent properties of the materials intended to be stained should be tested likewise. It will be better for inexperienced hands to coat twice or three times with a weak stain than only once with a very strong one, as by adopting the first mode a particular tint may be gradually effected, whereas, by pursuing the latter course, an irremediable discolourization may be the result. Coarse pieces of carving, spongy end, and cross-grained woods, should be previously prepared for the reception of stain; this is best done by putting on a thin layer of varnish, letting it dry, and then glass-papering it completely off again. Fine work merely requires to be oiled and slightly rubbed with the finest glass-paper. Thus prepared, the woody fibre is enabled to take on the stain more regularly, and to retain

a high degree of smoothness. When stain is put on with a flat hog-hair tool, it is usually softened by a skilful but moderate application of a badger-hair softener. The steel comb is chiefly employed for streaking artificial oak, and the mattler is used for variegating and uniting the shades and tints of mahogany. Flannels and sponges are often worked with instead of brushes, but the implements most serviceable for veining or engraining purposes are small badger sash tools and sable pencils. The effect produced by a coat of stain cannot be ascertained until it has been allowed a sufficient drying period.

Worrall's Process for Imitating Woods.—The surface of the wood is first made perfectly smooth and level, and if close-grained the surface is covered with strong or dilute alkalies, such as potash, soda, and ammonia, or other alkalies and their carbonates, or with ethylic, or methylic ethers and alcohols, or spirits of turpentine, camphine, benzole, and chloroform, or with oils of, or solutions of, soaps, hot or cold, so as to soften and dissolve out the resinous substances naturally present in the cells or pores of the wood. If the wood is very close-grained, the surface is to be covered with any corrosive acid, such as concentrated sulphuric, nitric, hydrochloric, or chromic acids, so as to corrode, or etch the soft parts of the wood, and leave the harder parts elevated, and to enlarge the pores; this process is repeated until the desired effect is obtained.

Imitating Oak Wainscot. — 1. To make American ash like oak wainscot, both in vein and shade, commence by sketching out, upon certain parts of the ashen exterior, the requisite white veins by means of a camel-pencil with white stain; that done, coat the veins with thin varnish, and then darken the general ground, dealing carefully throughout the entire process with the veined portions. 2. The best mode of producing a representation of oak wainscot upon white materials like beach and fir, is as follows;—A coat of Stephens' satin-wood stain is regularly laid on, then a soft graining comb is gently drawn along the stained space, and when the streaks are all correctly produced, the veins are formed with white stain, made by digesting $\frac{3}{4}$ oz. pearl white, subnitrate of bismuth, and 1 oz. of isinglass, in 2 gills of boiling water. The tone of this stain may be modified by being diluted with water, or tinted with other stains.

To Imitate Various Woods.—Showy elmroot, after being delicately darkened, passes in appearance for Italian walnut. To imitate the contour and rich ground of rosewood upon inferior white materials, produce the ground shade by sponging with a decoction of Brazil wood, and the fibril veins by brushing partially with black liquor, which is prepared by boiling logwood chips, sulphate of iron, and steel filings, in equally proportioned quantities of vinegar and water. Sometimes a graining comb is passed over the ground shade longitudinally, and with a slight vibrating motion, so as to effect natural-looking streaks, previous to the pencilling or veining. The aspect of ebony may be given to any species of wood by the application of three distinct coats of black liquor; and after being smoothed, the counterfeit ebony may be embodied with white polish; this greatly helps to preserve the transparent density of the dyed material.

There is a method of colouring woods not generally known in the trade; the surface to be coloured is smeared with a strong solution of permanganate of potash, which is left on for a longer or a shorter time, according to the shade required; in most cases 5 minutes suffice. Cherry and pear tree woods are most easily attacked, but a few experiments will serve to show the most favourable circumstances; the woody fibre decomposes the permanganate, precipitating peroxide of manganese, which is fixed in the fibre by the potash simultaneously set free. When the action is ended, the wood is carefully washed, dried, and afterwards oiled and polished in the ordinary way. The effect of this treatment on many kinds of wood is surprising, particularly on cherry woods, to which a beautiful red-

dish tone is communicated. The colour is permanent in light and air.

Mordants.—The virtues of dye-stuffs may be much enhanced by the addition of a mordant to modify and fasten the shades they impart. Spirit of nitre for the satinwood stain; a powerful solution of oxalic acid for the oak; and dilute nitrous acid for the mahogany.

Imitating Mahogany.—When curly-veined birch and beech have been regularly brushed with aquafortis and dried at the fire, they both look remarkably like mahogany. A decoction of logwood and fustic, when put on in a tepid state, produces a similar effect. The French mode consists in brushing the white timber with a dilute solution of nitrous acid; it is then coated once or twice with finishing spirit, in which a quantity of carbonate of soda and dragon's-blood has been dissolved, the proper proportions to 1 gill of spirit being $\frac{3}{4}$ of an ounce of the soda, and $\frac{1}{4}$ of an ounce of the blood; the wood is afterwards finished with varnish or polish of a reddish-brown tint. In producing this shade of colour, London stainers frequently use a rich brownish-red kind of chalk, the colour of which is analogous to that of fine Spanish mahogany. It is commonly applied in the form of a dry powder, by means of a brush, and then well rubbed with another brush or coarse flannel.

To Stain Beech a Mahogany Colour.—Put 2 oz. of dragon's-blood, broken in pieces, into a quart of rectified spirits of wine; let the bottle stand in a warm place, shake it frequently; when dissolved it is fit for use.

Imitation of Mahogany.—Plane the surface smooth, and rub with a solution of nitrous acid. Then apply with a soft brush 1 oz. of dragon's-blood dissolved in about a pint of alcohol, and with $\frac{1}{3}$ of an ounce of carbonate of soda mixed and filtered. When the brilliancy of the polish diminishes, it may be restored by the use of a little cold-drawn linseed oil.

Mahogany Stain.—Dark.—1. Boil $\frac{1}{2}$ lb. of madder and 2 oz. of logwood chips in 1 gall. of water, and brush well over the wood while hot; when dry, go over the whole with pearlash solution, 2 drams to the quart. *Light.*—2. Put 2 oz. of dragon's-blood, well bruised, into 1 quart of oil of turpentine; let the bottle stand in a warm place, shake frequently, and when dissolved, steep the work in the mixture. 3. Raw and burnt sienna. Grind the raw sienna on a painter's stone, mixed with beer; this will give a very light mahogany stain. Then grind the burnt, and add as much of it to the raw sienna as is required to make it the necessary colour; lay it on moderately thin with a brush, and then wipe it off with a piece of wadding or cotton wool; when dry, oil, size, varnish, or polish it, whichever required. It is very cheap.

To Remove Stains from Mahogany.—Mix 6 oz. of spirit of salt and $\frac{1}{2}$ oz. of powdered salt of lemons. Drop a little of this mixture on the stains, and rub well with a cork until they disappear, then wash off with cold water.

Imitating Rosewood.—1. A transparent liquid rose-pink, used in imitating rosewood, consists in mixing $\frac{1}{4}$ lb. of potash in 1 gall. of hot water, and $\frac{1}{4}$ lb. of red sanders wood is added thereto; when the colour of the wood is extracted, $2\frac{1}{2}$ lbs. of gum shellac are added and dissolved over a quick fire; the mixture is then ready to be used on a groundwork made with logwood stain. 2. Boil $\frac{1}{2}$ lb. of logwood in 3 pints of water till it is of a very dark red, add $\frac{1}{2}$ oz. of salts of tartar. While boiling hot, stain the wood with two or three coats, taking care that it is nearly dry between each; then with a stiff flat brush, such as is used by the painters for graining, form streaks with black stain. This imitation will very nearly equal the appearance of dark rosewood. 3. Stain with the black stain, and when dry, with a brush as above dipped in the brightening liquid, form red veins in imitation of the grain of rosewood. A handy brush for the purpose may be made out of a flat brush, such as is used for varnishing; cut the sharp points off, and make the edges irregular by cutting out a few hairs here and there, and you

will have a tool which will actually imitate the grain.

Bronzing Inlaid Work.—A method used for decorating inlaid work is the use of a bronzing liquid, which consists of a fluid bronze composition formed by combining metallic powder of gilding and bronze powder with collodion, which composition is capable of being applied as a bronze liquid to surfaces of wood, iron, or any solid material, for the purpose of coating the same for decoration or preservation.

To Imitate King or Botany Bay Wood.—Boil ½ lb. of French berries in 2 quarts of water till of a deep yellow, and while boiling hot give two or three coats; when nearly dry, form the grain with black stain, which must also be used hot. For variety, to heighten the colour, after giving it two or three coats of yellow, give one of strong logwood liquor, and then use the black stain as directed.

Black Stain.—Boil 1 lb. of logwood in 4 quarts of water, add a double handful of walnut peel or shells; boil it up again, take out the chips, add a pint of the best vinegar, and it will be fit for use; apply it boiling. This will be improved, if, when dry, a solution of green copperas, an ounce to a quart of water, is applied hot over the first stain.

Black Stain for Immediate Use.—Boil ½ lb. of chip logwood in 2 quarts of water, add 1 oz. of pearlash, and apply it hot to the work with a brush. Then take ½ lb. of logwood, boil it as before in 2 quarts of water, and add ½ oz. of verdigris and ½ oz. of copperas; strain it off, put in ½ lb. of rusty steel filings; with this go over the work a second time.

Brown Stain.—Paint over the wood with a solution made by boiling 1 part of catechu, cutch, or gambier, with 30 parts of water and a little soda. This is allowed to dry in the air, and then the wood is painted over with another solution made of 1 part of bichromate of potash and 30 parts of water. By a little difference in the mode of treatment, and by varying the strength of the solutions, various shades of colour may be given with these materials, which will be permanent, and tend to preserve the wood.

Red Stain.—1. Take 1 lb. of Brazil wood to 1 gall. of water, boil 3 hours with 1 oz. of pearlash, brush it hot on the wood, and while hot brush the wood with a solution made with 2 oz. of alum in 1 quart of water. 2. An infusion of Brazil wood in stale urine, in the proportion of a pound to a gallon for wood; to be laid on when boiling hot, and should be laid over with alum water before it dries. Or, a solution of dragon's-blood in spirits of wine may be used.

Red Stain for Bedsteads and Common Chairs.—Archil will produce a very good stain of itself when used cold; but if, after one or two coats being applied and suffered to get almost dry, it is brushed over with a hot solution of pearlash in water, it will improve the colour.

Walnut Stain.—Water, 1 quart; washing soda, 1½ oz.; Vandyke brown, 2½ oz.; bichromate of potash, ¼ oz. Boil for 10 minutes, and apply with a brush, in either a hot or cold state.

Oak Stain.—Equal parts of American potash and pearlash—2 oz. of each to about a quart of water. This gives a good stain; it requires careful application, as the American potash is a strong solvent, and will blister the hands; it softens a good paint-brush once using, so use a very common brush, and apply the staining with it. Keep it corked up in a bottle, and it is always ready for use; if it strikes too deep a colour, add more water.

Ebony Stains.—1. Stain work with the black stain, adding powdered nut-gall to the logwood and copperas solution, dry, rub down well, oil, then use French polish made tolerably dark with indigo, or finely-powdered stone blue. 2. Hold an ordinary slate over gas, lamp, or candle, until it is well smoked at the bottom, scrape a sufficient quantity into French polish, and well mix; then polish the article in the ordinary way. If there are any lumps gently rub them down and apply another coat. 3. Prepare a decoction of logwood by adding a small

handful of chips to a pint of rain water. Allow this to simmer until reduced one-fourth, and whilst the liquor is hot dress the work to be ebonized two or three times. To the remainder of the liquor add two bruised nut-galls, a few very rusty nails, bits of iron-hooping, or a piece of sulphate of iron the size of a walnut, and as much more rain water as will make about three-quarters of a pint of liquor. Apply this, which will be a black stain, hot as before, giving two coats, and when thoroughly dry, polish with ordinary French polish, to which sufficient powdered thumb-blue has been added to perceptibly colour the polish. Use a glazed pipkin in which to prepare the stain. Take care that no oil or grease comes in contact with the brushes used or the surface of the wood until ready for polishing. Let each coat of stain dry before the next is added, and rub down with well-used, fine glass-paper. Sycamore, chestnut, and plane-tree, are the best woods for ebonizing in the above manner. 4. Infuse gall-nuts in vinegar in which rusty nails have been soaked, rub the wood with the infusion, dry, polish, burnish. 5. Stain in the first place with a hot saturated solution of logwood, containing a little alum; and, when dry, brush it over with common writing ink.

Graining Woods.—GROUNDS.—These are generally applied by the house painter, ready for the grainer. When the grounds are finished to the tint required for the woods to be imitated, they must be left to get quite dry; the work is then ready for the graining operations.

Mahogany.—Orange chrome, Venetian red, and white-lead mixed in such proportions as will give the desired tint. Vermilion, raw and burnt sienna, are also employed to modify the shades.

Rosewood.—Vermilion, Venetian red, a little scarlet lake, and white-lead. For ordinary work the scarlet lake may be dispensed with.

Bird's-eye Maple and Satin Wood.—White-lead mixed with a little yellow ochre, care being taken not to make the ground of too dark a tint, as the varnish to be afterwards applied will still further darken it. All the colours for these light grounds must be rubbed quite smooth, and be well strained.

Dark Oak.—1. Raw sienna, burnt umber, white-lead, and Venetian red. 2. Yellow ochre, Venetian red, and white-lead.

Wainscot Oak.—Dark.—Oxford ochre, white-lead and Venetian red, or chrome, yellow ochre, and white-lead.

Light.—Yellow ochre and white-lead; the desired tint is obtained by the use of more or less of the yellow ochre.

Oak Graining in Oil.—1. Vandyke brown and raw sienna for dark oak, or finely-ground burnt umber and raw sienna for a lighter tint, mixed with equal parts of turpentine and linseed oil. Add patent driers. Lay this colour on thinly and evenly with a large brush; it does not dry very rapidly. Care must be taken not to lay on too much colour, or it is liable to have a dirty appearance. Stipple with a dry dusting brush, so as to distribute the colour evenly over the work. As in real oak it is invariably found that one side of a slab is coarser than the other, this peculiarity of pattern must be imitated in the combing process. Take a cross-cut gutta-percha comb, and draw it down one side of the panel, use a finer comb to complete it. This operation produces straight lines of the grain from top to bottom. Next take a fine steel comb, and go over all the previous combing; in drawing the comb down, give it a short, quick, wavy motion, or move it diagonally across the first lines, thus imitating the pores of the real wood. Cork combs may also be used, and some grainers use a coarse steel comb, with a fold of thin rag placed over the teeth. By a skilful combination of the combs, and a tasteful variation in their use, the different kinds of oak may be most successfully imitated. In graining joints of the various portions of a piece of a work, it must be remembered that in the real wood some of the grain would necessarily have a perpendicular direction, and another part would run horizontally, and that one part would

appear lighter than another, owing to the different angles in which it would receive the rays of light. After combing, the figure, or veining, must be wiped out before the colour is dry. Hold several thicknesses of fine rag, or a piece of clean wash-leather over the thumb nail, wipe down a few veins, then move the rag or leather slightly, so as to present a clean surface for the next wipe. A piece of thin gutta-percha, softened in warm water, and pressed to the shape of the thumb, may be used to preserve the nail, but cannot be relied on to remove the colour so cleanly as the nail covered with rag or leather; it is useful for common work, as it protects the nail from injury and wear. After having wiped the figures, they must be softened in appearance by still further wiping the grain away from their edges with a small roll of clean rag, so as to imitate the appearance of the wood, where the grain is always darker than the parts next to it. When the oil colour is dry it must be overgrained.

Overgraining.—This operation is performed in the same manner both upon work which has been oil grained or spirit grained. In overgraining, water-colours are used; and, in order to make them adhere to the underlying graining, whether in spirit or in oil, it is necessary to prepare the work to receive them, otherwise they would run off the surface at once. One method is to rub dry powdered whiting quickly over the surface with a soft rag, removing superfluous powder afterwards, and the grainer can at once finish the work. Another plan, which is principally used when a large piece of work is in hand, is to rub a mixture of fullers' earth and water over the graining, and wait until it is perfectly dry before commencing to overgrain. Grind Vandyke brown, or burnt umber in water, and thin with equal proportions of water and table-beer. The colour should be a trifle darker than the undergraining; a little practice will teach the tints that are best suited to the various woods to be imitated. The colour is applied by a wide hog brush, drawn over the work, generally in the direction of the veins formed by the combing. There are several descriptions of overgraining brushes in use; those most generally employed are thin and flat, with occasional intervals between the tufts of hair. The knots and figures must be lightly touched up with the overgrainer, and the whole gone over quickly with a badger softening brush. The overgraining dries quickly, and the varnish may be then applied, although it is well to wait some hours, so as not to run any risk of removing the graining colour. Sometimes a tolerably strong solution of soda with a little burnt sienna is used for the figures, applying the mixture where these are required, and then washing over the work with a sponge and water. Wherever the soda has been applied, the graining colour will be removed. Go over the whole with a wash made of equal parts of table-beer and water, and then overgrain, as above described. As a general rule avoid harsh contrasts between the graining colour and the ground. 2. In the mixing of oil graining colour it is necessary that the colour should work clean and free. Sometimes the colour will work stiff and dirty, and in this state will not only produce dirty work, but will occupy thrice the time in rubbing in, compared with colour properly mixed. Oil graining colour also requires to be megilped—that is, oil colour alone will not stand when it is combed; the marks made with the comb will all run one into the other, and will thus be obliterated. To prevent this running, the colour requires to be megilped, so that the comb marks will retain the exact form left by the comb. This is accomplished by the use of beeswax, soft soap, hard soap, lime water, whiting, and pure water. When beeswax is used, the best means of dissolving it is to cut the wax into thin shavings or shreds; these are put into a suitable can half filled with pure linseed oil, into which a red-hot poker is plunged, and stirred well. This will dissolve the wax thoroughly and mix

it with the oil. When the wax is all dissolved, the vessel should be filled with either oil or turpentine, which further dilutes and mixes the wax, and serves also to prevent it from congealing, so that it may mix with the graining colour thoroughly. This should be seen to, or else the wax is apt to remain in lumps; and when the colour is spread upon the work, for graining, the wax will be spread unequally, and will not dry in parts, so that it is absolutely necessary that the wax should be thoroughly mixed with the graining colour to produce good work. If soft soap is used, it should first be thoroughly worked up on a palette or a board with either whiting or patent driers; this breaks up the soap, and amalgamates it with the driers, and it will then mix properly with the graining colour. Another method is to break up the soft soap in water to a thick froth or lather; in this state it may be beaten up with water and thoroughly mixed with the oil colour. When the lime water is used, about 2 lbs. of slaked lime should be thoroughly mixed in a pint can full of water, and the lime allowed to settle; a portion of the water may then be added to the graining colour, and the two well stirred together until they are thoroughly amalgamated. If whiting is used, it should be ground in oil, and then mixed with the graining colour. Pure water will also answer the purpose. The wax is the most effectual, but there are some objections to its use. On the whole, pure water is preferable, for if it is well mixed with the oil colour, it megilps it sufficiently to hold the combing until it sets; the water then evaporates and leaves no injurious effects behind, and the projection of the grain is less than it is if any other medium is used. The most useful colours for mixing oak-graining colour are raw and burnt Turkey umber, Oxford ochre, Vandyke brown, and burnt sienna. The first three, with the addition of ivory black, are all that is required for mixing any shade of graining colour. For light oak or wainscot graining colour, mix $\frac{2}{3}$rds linseed oil with $\frac{1}{3}$rd turpentine; add a little Oxford ochre and raw Turkey umber in sufficient quantity, according to the shade required and amount of stuff mixed. Terebine or liquid driers should be added, the quantities being regulated according to whether the graining colour is required to be quick or slow drying. A safe quantity to use, if the liquid drier is of the best quality, is about $\frac{1}{2}$ oz. to a pint of colour. This will cause the colour to dry in about 7 or 8 hours, but twice the quantity may be used with safety if the colour is required to dry very quickly. Sugar of lead ground in oil may be used as a drier for graining colours, but the liquid drier is better. After adding the liquid driers, beat or stir well up together; add pure rain water in the proportion of $\frac{1}{2}$ pint of water to 3 pints of oil and turps; beat or stir up until the whole is thoroughly mixed together, after which strain through a fine strainer or a double fold of fine muslin. The colour should be thinned until it works freely and lays on well, so that when the colour is being brushed over the work to be grained, it will lay on evenly, and be easily spread, and will look clean and of one uniform shade of colour. Care and cleanliness of working are necessary to the successful carrying out of this work; and it is essential that the colour, the brushes, and all working tools should be clean to begin with, and be kept clean.

Oak in Spirit Colour.—This is less durable than oak graining in oil, and is not therefore so much used for outside work, but it does not require so long a time in its working, as it dries rapidly. For the graining colour rub up whiting in turpentine, add enough burnt umber and raw sienna, dilute with turps, a little boiled oil, and gold size. Strain carefully, and it is ready for use. In laying this on, cover only a small part of the work at a time before combing, as it dries very quickly, and be careful to spread it evenly and thinly over the work. The combs used are made of steel, horn, or leather. After combing the veins and removing any superfluous graining colour from corners or small

parts of the work, let it stand for a snort time. The flower of the wood has next to be imitated, by removing some portions of the graining colour with a small veining fitch. The spirit graining colour when used for this purpose must have a little turpentine added to it; apply with the fitch where the flower is required, then rub the places quickly with a piece of old flannel, which will remove the graining colour and show the light ground underneath. The light veins and half-lights are also obtained by similar means, either removing the graining colour or merely smudging it aside over the veins. The overgraining is performed in the manner described for the oak graining in oil.

Graining Oak in Distemper. — This process is now seldom used, although it stands exposure to the weather, without fading, for a great length of time. For colour, dissolve gum arabic in hot water, and make a mixture of it with whiting, raw sienna, and Vandyke brown ground in beer. Colour the work evenly, brush it down with a dry dusting brush, comb while the colour remains wet, then let it get quite dry. Put in the veins with a small brush dipped in clean cold water. After a few seconds run a dry soft duster down the work to remove the colour from the veins. Then lay on a thin coat of Turkey umber ground in table-beer or ale, put on with an overgraining brush. If too much gum is put in the colour it is likely to crack and blister, whilst if there is not sufficient the veins will not be clearly marked by the wiping out.

Bird's-eye Maple.—1. Graining colour —equal parts of raw sienna and burnt umber mixed in ale, of two thicknesses. First lay on an even coat of the thinner mixture, then with a smaller brush put in the darker shades, mottle and soften with a badger-hair brush. The eye is imitated by dabbing the colour whilst still wet with the tops of the fingers. When dry, put on the top grain in the most prominent places, and shade the eyes with a little burnt sienna. Some grainers use small brushes called maple eye-dotters, instead of the fingers, for forming the eyes. Various forms of brushes are used for the mottling; some consist of short camel hair closely set, whilst to give the wavy appearance hoghair mottlers are used, with long hairs, against which the fingers are pressed as the brush is drawn over the work, causing it to assume a variety of pleasing curves. The lines to imitate the heart of the wood are put in with a small brush, and the outer lines parallel to the heart are formed with the overgraining brush. Overgraining brushes for maple consist of a number of small sable brushes mounted at a little distance from each other in a frame, and resembling a comb in its appearance. 2. Grind equal parts of raw and burnt sienna in a mixture of water and ale. Coat the work evenly with this colour, then rub it down with a long piece of buff leather, cut straight at the edge and pressed closely against the work. Proceed for the imitation of the eyes and heart of the wood as before directed. 3. For outside work grind the raw and burnt sienna with a little of the patent driers, and then with boiled oil. Lay on an even coat, and rub down with a piece of buff leather. Soften, and when dry put on a top grain of burnt umber and raw sienna ground in ale. 4. Burnt umber or Vandyke brown laid on unevenly, darker in some places than others, after the character of the wood; a coarse sponge does for this purpose very well. When the colour is disposed over the surface it must be softened down with the badger-hair tool, and the knots put in with the end of a hog's-hair fitch, by holding the handle between the thumb and finger, and twisting it round; these knots may be afterwards assisted by a camel-hair pencil. A few small veins are frequently found in maple; these may be wiped off with a piece of wash-leather. When this is dry the second or upper grain may be put on; some of the first colour diluted will do for this second grain. To put on this grain use the flat hog's-hair brush, and the hairs combed out to straighten or separate them. As soon as the grain is put on, the softener should be passed lightly across the grain

in one direction only; this will make one edge of the grain soft and the other sharp, as it occurs in the wood. After the second grain is dry it may be varnished.

Mahogany.—1. Vandyke brown and a little crimson lake ground in ale laid on, allowed to dry and then smoothed, forms the ground. Then lay on a second thicker coat, soften with a badger-hair brush, take out the lights whilst it is wet, and imitate the feathery appearance of mahogany heart. Soften, and top grain with Vandyke brown laid on with an overgraining brush of flat hog-hair combed into detached tufts. In softening, be careful not to disturb the under colour. 2. Grind burnt sienna and Vandyke brown in ale, lay on a coat, mottle with a camel-hair mottler, and soften. When dry, overgrain as above.

Pollard Oak in Distemper. — The ground is a mixture of vermilion, chrome yellow, and white-lead, to a rich buff. The graining colours are Vandyke brown, a little raw and burnt sienna and lake, ground in ale. Fill a large tool, lay on an even coat, and soften with the badger-hair brush. Take a moistened sponge and dapple round and round in circles, then soften lightly, and draw a softener from one set of circles to the other while wet, to form a number of grains, finish the knots with a hair pencil. When dry, put the top grain on in a variety of directions, and then a coat of turpentine and gold size mixed. When this is dry, glaze with Vandyke brown mixed in beer.

Pollard Oak in Oil.—Ground the same as for pollard oak in distemper. Graining colours, equal portions of Vandyke brown and raw sienna, ground separately in boiled oil very stiff; mix them together, and thin the whole with spirit of turpentine. With a large brush lay on a thin coat, and, while wet, take the flat graining brush dipped in the colour, and dapple in various directions; then dip the brush into burnt umber thinned with spirit of turpentine, and form the knots. When the colours are set, dip a flat brush into a thin glaze of burnt umber, and put the grain on in a curly direction. Have enough oil in the colours to bind them, and finish only a small part of the surface at once, in order to keep it moist. For making the knots a cork should be held on to a patch of the dark colour, and twisted round between the thumb and finger. The heart of the wood should be taken out with a graining fitch.

Satin Wood.—1. Graining colour.—Equal parts of raw umber and raw sienna, a little whiting and burnt sienna, all ground in ale. Colour evenly, and soften, then mottle and feather same as for mahogany. Soften, and allow to dry; overgrain with the same colour. 2. Grind raw sienna and whiting in ale very thin, and colour the surface. Soften whilst wet, and take out the lights with a mottling brush; when dry, overgrain with the same colour applied with a flat brush.

Yew Tree.—Ground, reddish yellow. For graining colour, grind equal parts of Vandyke brown and burnt sienna in ale, with a little raw sienna. Lay this colour on evenly when the ground is dry, and soften. Cut a piece of cork to a tolerably sharp edge, rub it across the work, and soften the same way as the grain, as in curled maple. When dry, dab the work over with the graining colour on the tips of the fingers to form the knots; shade them underneath with a camel-hair brush. When dry, overgrain.

Rosewood.—Ground, chrome yellow, vermilion, and white-lead. For the graining colour grind ivory black and burnt sienna very fine, mix, and lay on, then soften. When dry, put on the top grain in a curly figure, with a small graining brush well filled with ivory black. Shade up the knots with a camel-hair brush, and finish with a glaze of rose-pink.

Hair-wood.—1. First lay on a coat of light grey, of white-lead ground in boiled oil, add a little Prussian blue, and mix with turpentine. For ground colour use the same paint made much thinner with turpentine, laid on as soon as the first coat is dry. The ground colour must only be applied on a small piece at

a time, as it must be grained before it dries. For the graining use some of the ground colour, to which add a little Prussian blue, apply this with a feather, in long veins. Overgrain with the ground colour. 2. Mix white-lead and turpentine, and add a little Prussian blue, for the ground colour. For the graining colour, Prussian blue and raw sienna ground in ale. When the ground is dry, lay on a thin coat of the graining colour and soften; put on the long grain with a mottler drawn across the work. Soften, and overgrain in a perpendicular but wavy figure.

Graining Roller.—This tool consists of a roller of wood or metal mounted on a spindle, to which are attached a frame and a handle. Around the wooden roller is a wrapper of leather, on which is cut or stamped an imitation of the grain of a certain wood. The leather used for the roller is of thick hide. The pattern is sketched on one side, and then the ground is cut away to a certain depth, just as a block cutter would do for printing. In some cases the strip of leather is made fast to the roller, and only just covers it; in other cases the leather will be three or four times the circumference of the roller. The distemper graining colour is brushed over the work to be grained, and, while it is wet, the roller, which has previously been damped with a wet chamois leather, is passed over it, and as the roller passes along it takes up the colour in patches of the exact shape of the pattern on the roller used. This is then softened with the badger-hair softener, and overgrained. By a judicious use of these rollers, using only a part of the circumference, and changing the direction, the patterns may be obtained in great variety. The mottle of satinwood, mahogany, Hungarian ash, and birch is well imitated by these rollers, and also the beautiful feathers or curls in Spanish mahogany and satinwood. The mottle of these woods has very little variety, so that one or two patterns suffice for all; and this class of woods is peculiarly suitable for imitation by these rollers. To use the rollers for the imitation of mahogany, satinwood, birch, and maple, lay the colour, mixed in beer, on the surface, pass the roller over it whilst it is wet, soften, and overgrain with a hog-hair overgrainer, previously combed to separate the hair. The roller should occasionally be passed twice over the same place, and in some parts plain spaces left, so as to prevent a repetition of the patterns; put in the maple eyes by hand in the usual way. Before overgraining the graining should be covered with a coat of turpentine, gold size, and a little varnish to bind it, so that the colour may not be removed by the overgraining. For oak lay the colour on as regular as possible, and comb as in ordinary work, a little common flour paste being added to the water colour, to enable it to stand the comb. Then pass the roller over it, and the badger, in the same direction as the combing. Overgrain same as mahogany, after the application of the mixture of gold size, varnish, and turpentine. The rollers must be kept quite clean, and free from grease or oil. Before commencing work, wet the rollers thoroughly with a sponge and water, and rub them with a wash-leather or dry cloth, so as to remove any water remaining on the surface. Whilst using the rollers, have a piece of wash-leather at hand, over which they should be frequently passed to keep them quite clean, and prevent the accumulation of colour on their surfaces, which would clog up the pattern. After use, wash them well with a brush and water, and let them dry gradually; do not apply heat, as that is likely to crack the surface.

Marbling on Wood. — *Verde Antique.*—If the work is new, lay on a coat of dark lead oil colour. When dry, smooth with glass-paper, and lay on a coat of black paint. When the ground is dry, mix some white-lead with water and a little beer. Lay this on in large streaks. Fill up the spaces left with veins of lampblack, finely ground in beer, thus covering the whole surface of the work. While still wet soften with a badger-hair brush, so as to cause the veins to run into one another. On the darkest parts of the work lay dabs of

white, carelessly applied, to imitate fossils, and dab over the light parts of the work with the black colour for the same purpose. With a thin flat graining brush, or a feather, dipped in the white, form small veins over the black; a few dark blue wavy veins may also be put on. When dry, glaze with a thin coat of raw sienna and Prussian blue, ground in spirit of turpentine and mixed in copal varnish. A little emerald green added here and there heightens the effect.

Oriental Verde Antique.—Lay on a ground of black in oil. Mix white-lead in oil, thinned with turpentine for the graining colour. Lay this on in broad transparent veins of irregular depth of colour, and whilst wet dab it over with a piece of wash-leather in different parts to imitate fossils; then with a small piece of cork, twisted round on the work between the finger and thumb, produce a number of little spiral figures of various sizes and shapes. Cut notches on the top of a feather, dip it in the white, and pass it over the black ground in zigzag and fantastic veins, with occasional sharp angles. Let all the work get quite dry, and then glaze with green, in some parts with Prussian blue, in others with raw sienna, leaving some portions untouched. When dry, wash with beer, dip a feather into the whiting ground, and draw fine veins. To finish, give a coat of glaze, made of a little Prussian blue and raw sienna, mixed in equal parts of boiled oil and turpentine, leaving some of the white veins unglazed.

Jasper Marble.—Mix the ground the same as for mahogany, with red-lead, Venetian red, and a little chrome yellow, thinned with equal parts of oil and turpentine; lake or vermilion may be substituted for the Venetian red, if a brilliant tint is desired. Whilst the ground is wet dab on some spots of white, soften with a softening brush, and other colours may be applied in the same manner. When dry, put on the veins with a camel-hair brush.

Black and Gold Marble. — Ground, deep ivory black. Put on veins of white-lead, yellow ochre, and burnt and raw sienna, with a camel-hair brush. The spaces between the veins must be glazed over with a thin coat of grey or white, over which pass a few white veins. The veins may also be put on with gold leaf. Another method is to have a yellow ground, streaked with broad ribbons of black, in which fine veins are obtained by drawing a sharp piece of wood along them whilst wet, so as to expose the yellow beneath.

Sienna Marble. — 1. Ground, Oxford ochre and white-lead. Use burnt and raw sienna, white, black, and a little lake, for marbling. These colours should be laid on as a transparent glaze, and marked and softened while wet. The colours should be properly softened with a badger brush. 2. Ground, raw sienna or yellow ochre. When dry, mix raw sienna with white-lead, have ready also some white paint, put in broad transparent tints of white and yellow, and while wet blend them together with a softener. Mix Venetian red and a little black, and put in some broad veins in the same direction as the patchy tints run; for the darker veins take a mixture of Venetian red, lake, and black, and draw them over the first layer of veins with a feather, in fine threads, running to a centre, and in transparent veins in different directions. Mix some Prussian blue and lake, and put in the darkest and finest veins over those before laid on. Put in a few touches of burnt sienna between the fine veins, which are formed into small masses. All the colours should be ground in spirit of turpentine and mixed with sufficient gold size to bind them.

Dove Marble.—Ground, lead colour, of which it will be necessary to give two or three coats. If the work is new, let it dry hard, rub it smooth with fine glass-paper after each coat, and do not rub the paint off the sharp edges of the wood. For the marbling, take lead colour, such as used for the ground, thin it with turpentine, and rub a light coat over a small part of the work; and with a whitish colour form the small specks or fossil remains. Proceed, piece by piece, till the whole surface is covered,

being careful to paint but a small part of the ground at once, so that the colours may have sufficient time to blend together while wet, otherwise the work will appear harsh. Then with a small sash tool, put in faint, broad veins of the thin ground colour, and numerous very fine veins over the whole surface of the work, crossing each other in every direction. Then make the colour a little lighter, by adding white-lead, and with a feather pass over the broad veins in the same direction, forming streams of threads. With thin white, and with a camel-hair pencil go partly over the same vein with short thick touches, then with a fine striping pencil. When the work is hard, it should be smoothed with very fine glass-paper before being varnished. The first layer of veins should be very faint, so as to be scarcely perceptible; for, as the lighter shades are put on, the former veins will appear sunk from the surface of the work, which will give a good effect where the work is exposed to close inspection.

Blue and Gold Marble.—Ground, a light blue; when dry, take blue with a small piece of white-lead and some Prussian blue, and dab on in patches, leaving portions of the ground to show between. Blend together with a softener; next put on white veins in every direction, leaving large open spaces to be filled up with a pale yellow or gold paint. Finish with fine white irregular threads.

Italian Marble.—Ground, a light buff. For marbling, mix stiff in boiled oil white-lead, Oxford ochre, and a little vermilion; grind burnt sienna very fine in boiled oil, and put it into another vessel; mix pure white stiff in oil, and keep this also separate. Thin these colours with turpentine, and have a brush for each. Take the buff brush moderately full of colour, and dab it on in patches, varying as much as possible; take another brush and fill in the spaces between with sienna. With a softener blend the edges together, making them as soft as possible. Draw a few thin white veins over the work with a hair pencil, run in a few thin lines of sienna, and soften.

Black and White Marble.—White ground, and with dark veins, put on with a marbling crayon, and softened while the ground is wet. Or, when the ground is dry, cover it with a thin coat of white-lead, and put the veins in with a camel-hair pencil. Blend while wet.

Granite.—1. Grey ground, with white and black spots. 2. Venetian and white for the ground, with white, black, and vermilion spots. The spots are put on in several ways; a sponge may be charged with the marbling colour and dabbed on the work, or a common brush may be struck against a stick held at a little distance from the work, so as to throw off blots and spots of colour.

Porphyry.—1. Ground, purple-brown and rose-pink. Grind vermilion and white-lead separately in turpentine, and add a little gold size to each colour to bind it. More turpentine must be added before the colour is applied. When the ground is dry, fill a large brush with vermilion, squeeze out nearly all the colour by scraping the brush on the edge of the palette knife; hold a rod in the left hand, strike the handle of the brush against it, so as to throw small red spots on to the work till the surface is covered. Make the colour lighter by adding white-lead, and use as before. Then with clear thin white throw on very fine spots, and when dry put in a few white veins across the work. This marble may be imitated in distemper in precisely the same manner as in oil. 2. The ground is Venetian red, with a little vermilion and white. For marbling, add a little more white to the ground colour, and sprinkle over the first coat. When dry, repeat the splashing with a mixture of Venetian red and vermilion, and then with white in very fine spots. Form opaque white veins across the work, and transparent threads in various directions. This must be done when the work is dry and hard, with a sable pencil, and the threads drawn with a feather. For each separate colour use a different brush.

Paper.—*Ivory Paper.*—The pro-

perties which render ivory so desirable for artists are, the evenness and fineness of its grain, its allowing all water colours laid on its surface to be washed out with a soft wet brush, and the facility with which the artist may scrape off the colour from any particular part, by means of the point of a knife or other convenient instrument, and thus heighten the lights in his painting more expeditiously and efficaciously than can be done in any other way. These advantages are obtained in the paper made according to the following receipt, without any of the disadvantages of ivory, such as its limited size and changeable colour. Traces made on the surface of ivory paper by a hard black-lead pencil are much easier effaced by india-rubber than from common drawing paper, which, together with the extremely fine lines which its hard and even surface is capable of receiving, peculiarly adapts it for the reception of the most delicate kind of pencil-drawing and outlines. The colours laid upon it have a greater brilliancy than upon ivory, owing to the superior whiteness of the ground. Take $\frac{1}{4}$ lb. of clean parchment cuttings and put them into a 2-quart pan, with nearly as much water as it will hold; boil the mixture gently for 4 or 5 hours, adding water from time to time to supply the place of that driven off by evaporation; then carefully strain the liquor from the dregs through a cloth, and when cold it will form a strong jelly, which may be called size No. 1. Return the dregs of the preceding process into the pan, fill it with water, and again boil it as before for 4 or 5 hours; then strain off the liquor, and call it size No. 2. Take three sheets of drawing paper—outsides will answer the purpose perfectly well—wet them on both sides with a soft sponge dipped in water, and paste them together with the size No. 2. While they are still wet lay them on a table, and place them upon a smooth slab of writing slate somewhat smaller than the paper, turn up the edges of the paper, and paste them on the back of the slate, and then allow the paper to dry gradually. Wet as before three more sheets of the same kind of paper, and paste them on the others, one at a time; cut off with a knife what projects beyond the edges of the slate, and when the whole is perfectly dry, wrap a small piece of slate in coarse sand-paper, and with this rubber make the surface of the paper quite even and smooth. Then paste on an inside sheet, which must be quite free from spots or dirt of any kind; cut off the projecting edges as before, and when dry rub it with fine glass-paper, which will produce a perfectly smooth surface. Now take $\frac{1}{2}$ pint of the size No. 1, melt it with a gentle heat, and then stir into it 3 table-spooonfuls of fine plaster of Paris; when the mixture is complete pour it out on the paper, and with a soft wet sponge distribute it as evenly as possible over the surface. Then allow the surface to dry slowly, and rub it again with fine glass-paper. Lastly, take a few spoonfuls of the size No. 1, and mix it with three-fourths its quantity of water; unite the two by a gentle heat, and when the mass has cooled, so as to be in a semi-gelatinous state, pour one-third of it on the surface of the paper, and spread it evenly with the sponge; when this has dried pour on another portion, and afterwards the remainder; when the whole has again become dry, rub it over lightly with fine glass-paper, and the process is completed; it may accordingly be cut away from the slab of slate, and is ready for use. The quantity of ingredients above mentioned is sufficient for a piece of paper $17\frac{1}{2}$ by $15\frac{1}{2}$ in. Plaster of Paris gives a perfectly white surface; oxide of zinc mixed with plaster of Paris, in the proportion of 4 parts of the former to 3 of the latter, gives a tint very nearly resembling ivory; precipitated carbonate of barytes gives a tint intermediate between the two.

Manifold Writing Papers.—The white paper is only very fine thin writing paper. The black is soft paper, prepared by being smeared with a composition of grease and plumbago or lampblack; this mixture is allowed to remain on for 12 hours, and the paper then wiped smooth with a piece of wool

or cotton-waste. Place white paper over black, and write with a blunt point.

Enamelled Paper. — 1 lb. of parchment cuttings, ¼ lb. of isinglass, and ¼ lb. of gum arabic, in 4 galls. of water, are boiled in an iron kettle until the solution is reduced to 12 quarts; it is then removed from the fire and strained. The solution is divided into three parts of 4 quarts each; to the first portion is added 6 lbs. of white-lead, ground fine in water; to the second portion is added 8 lbs. of white-lead, and to the third is added 6 lbs. of white-lead. The sheets of paper are stretched out upon flat boards and brushed over with a thin coat of the first mixture with an ordinary painter's brush; the paper is then hung up to dry for 24 hours. After this the paper is ready to receive a coat of the second mixture, and again hung up to dry for 24 hours; the paper is then treated in the same way with the third mixture, and dried for 24 hours. After this it receives a high gloss, which is obtained by laying the work with its face downwards on a highly-polished steel plate, and then passing both with great pressure between a pair of powerful rollers. It is to be regretted that this enamelled surface is not very durable, as it comes off after wetting. To prevent this, a solution of some resinous substance may be added in the last operation.

Parchment Paper.—Dip ordinary unsized paper for 5 or 6 seconds into dilute sulphuric acid, and wash with extremely weak ammonia.

Test Papers are prepared by uniformly wetting sheets of unsized paper in solutions of litmus, buckthorn berries, Brazil wood, or other particular colouring matter required.

Lithographic Transfer Paper.—Make strong separate solutions in hot water of gum arabic 2 parts, by weight; starch, 6; alum, 1. Mix, and whilst moderately hot, give the paper two or three coats with a brush, allowing each coat to dry before the next is applied; finish by pressing. Another plan is to smear the paper with several cold coats of thin size, and then use solutions of white starch and gamboge water, allowing each coat to dry as before. Paper thus prepared is written on with litho. transfer ink, the back wetted, placed on a clean stone, and run through the press, when a reverse copy is obtained, which can be printed from in the usual way.

Wood Pulp for Paper.—Paper-makers at the present moment are surrounded with many difficulties, owing to the high price of materials and the unremunerative price of paper. Wood pulp has lately had a good deal of attention; it is now about the cheapest thing available, but must be worked with great care, or it will give a great deal of trouble. It requires to be worked in an engine by itself, unmixed with other materials; the roll should never under any circumstances be allowed to do anything but clear the stuff. Bleach is poison to it, and it requires more tinting if for printing paper than other material; a good dose of ultramarine and roseine making it a delicate purple-grey; if used in conjunction with straw it entirely destroys the harsh crackling feel of paper made from a large portion of straw; and, lastly, it absorbs hardly any power, and will help the turn out more than anything else, waste-papers not excepted. The greatest trouble to contend with in wood pulp is the uncertainty of moisture; this is a constant source of annoyance, and leads to disputes between the vendor and consumer. Some pulp invoiced at 50 per cent. moisture will often be found to contain 70 per cent., or even more. This, of course, upsets one's calculation of the cost of dry stuff or yield in paper. Makers of wood pulp intended for the open market should, therefore, sample their bales, and having dried the samples by artificial means, carefully ascertain the percentage of moisture contained, by deducting net weight of dry pulp from gross weight of pulp in bale, and invoice their goods faithfully as per sample. Consumers must not forget, however, that pulp stored in a damp place will absorb moisture from the atmosphere, whilst if stored in a warm dry room the bales will lose weight. The invoices would

be thus all the more reliable if the vendor stated the percentage of moisture in the pulp at a certain named temperature.

STAINING PAPER. — *Yellow.* — Paper may be stained a beautiful yellow by the tincture of turmeric formed by infusing an ounce or more of the root, powdered, in a pint of spirits of wine. This may be made to give any tint of yellow, from the lightest straw to the full colour, called French yellow, and will be equal in brightness to the best dyed silks. If yellow be wanted of a warmer or redder cast, annatto, or dragon's-blood, must be added. The best manner of using these, and the following tinctures, is to spread them even on the paper, or parchment, by means of a broad brush, in the manner of varnishing.

Crimson.—A very fine crimson stain may be given to paper by a tincture of Indian lake, which may be made by infusing the lake some days in spirits of wine, and then pouring off the tincture from the dregs. It may be stained red by red ink. It may also be stained of a scarlet hue by the tincture of dragon's-blood in spirits of wine, but this will not be bright.

Green.—Paper or parchment may be stained green, by the solution of verdigris in vinegar, or by the crystals of verdigris dissolved in water.

Orange.—Stain the paper or parchment first of a full yellow by means of the tincture of turmeric; then brush it over with a solution of fixed alkaline salt, made by dissolving ½ oz. of pearlash, or salts of tartar, in a quart of water, and filtering the solution.

Purple.—Paper or parchment may be stained purple, by archil, or by the tincture of logwood. Brush the work several times with the following logwood decoction;—1 lb. of logwood chips, ¼ lb. of Brazil wood, boiled for 1½ hour in a gallon of water. When dry, give a coat of pearlash solution, 1 dram to a quart, taking care to lay it on evenly. The juice of ripe privet berries expressed will also give a purple dye.

Staining Parchment.—Blue.—1. Dissolve verdigris in vinegar, and brush over with the solution hot till it becomes a perfect green, then well brush over with a solution of pearlash, 2 oz. to the pint, until it becomes a good blue. 2. Use the blue stain for wood, *viz.* copper filings dissolved in aquafortis; the material must be well brushed over with it, and then brushed over with a hot solution of pearlash, same strength as above, until it assumes a perfectly blue colour. 3. Boil 1 lb. of indigo, 2 lbs. of wood, and 3 oz. of alum in a gallon of water; brush well over until thoroughly stained.

Red.—1. Boil 1 lb. of Brazil wood and 1 oz. of pearlash in a gallon of water, and while hot brush over the work until of a proper colour. Dissolve 2 oz. of alum in a quart of water, and brush this solution over the above before it dries. 2. Use a cold infusion of archil, and brush well over with a pearlash solution, 2 drams to the quart.

Incombustible Paper may be made by mixing with the pulp a fluid obtained by adding to an aqueous solution containing 1¾ oz. of pure tallow soap, just enough alum to completely decompose the soap. The paper made with this requires no size.

Bleaching Paper. — Paper which has been very imperfectly bleached may be rendered thoroughly white by pouring upon it in succession, as dilute solutions, 3½ parts alum, 1 part chloride of barium, a little free hydrochloric acid, and ⅓ part calcined chalk — stirring well during the operation. The fibres of the paper become firmly coated with the brilliant white sulphate of barytes which is formed.

Pollen Powder, or Paper Powder.—Boil white paper, or paper cuttings, in water for 5 hours. Pour off the water, pound the pulp in a Wedgwood mortar, and pass through a fine sieve. This powder is employed by the bird stuffers to dust over the legs of some birds, and the bills of others, to give them a powdery appearance; also to communicate the downy bloom to rough-coated artificial fruit, and other purposes of a similar nature; it makes excellent pounce.

Papier-Mâché.—Two modes of making articles of papier-mâché are adopted;—either by gluing or pasting different thicknesses of paper together, or by mixing the substance of the paper into a pulp, and pressing it into moulds. 1. The first mode is adopted principally for those articles, such as trays, in which a tolerably plain and flat surface is to be produced. Common millboard, such as forms the covers of books, may give some idea of this sort of manufacture. Sheets of strong paper are glued together, and then so powerfully pressed that the different strata of paper become as one. Slight curvatures may be given to such pasteboard when damp, by the use of presses and moulds. Articles such as snuff-boxes are made by gluing pieces of paper cut to the size of the top, bottom, and sides, one on another, round a frame or mould, which is afterwards removed.

Polish.—Articles made of pasteboard have a fine black polish imparted to them in the following manner;—After being done over with a mixture of size and lampblack, they receive a coating of a peculiar varnish. Turpentine is boiled down until it becomes black; and three times as much amber in fine powder is sprinkled upon it, with the addition of spirit or oil of turpentine. When the amber is melted, some sarcocolla and more spirit of turpentine are added, and the whole well stirred. After being strained, this varnish is mixed with ivory-black and applied in a hot room, on the papier-mâché articles, which are then placed in a heated oven. Two or three coatings of the black varnish will produce a durable and glossy surface, impervious to water. 2. Papier-mâché, properly so called, is that which is pressed into moulds in the state of a pulp. This pulp is generally made of cuttings of coarse paper boiled in water, and beaten in a mortar till they assume the consistence of a paste, which is boiled in a solution of gum arabic or of size, to give it tenacity. The moulds are carved in the usual way, and oiled, and a pulp poured into them; a counter-mould being employed to make the cast nothing more than a crust or shell, as in plaster casts. In some manufactories, instead of using cuttings of made paper, the pulp employed by the paper-maker is, after some further treatment, poured into the moulds to produce papier-mâché ornaments.

Uses of Papier-mâché.—It has now, in some cases, superseded the carved and composition ornaments employed to decorate picture and glass frames; but it is in the ceilings and walls of rooms and the interiors of public buildings that papier-mâché is found most valuable. Plaster and composition ornaments are ponderous; carved ornaments are costly; but those of papier-mâché are light and of moderate price. Maps in relief are also occasionally made of papier-mâché. Paper roofs have been occasionally used. Sheets of stout paper are dipped in a mixture of tar and pitch, dried, nailed on in the manner of slates, and then tarred again; this roof is waterproof, but unfortunately very combustible.

Paper Casts from the Antique.—This method of obtaining facsimiles of sculpture in basso-relievo is very easy. Stiff, unsized, common white paper is best adapted for the purpose. It should be well damped; and, when applied to sculpture still retaining its colour, not to injure the latter, care should be taken that the side of the paper placed on the figures be dry—that is, not the side which has been sponged. The paper, when applied to the sculpture, should be evenly patted with a napkin folded rather stiffly; and, if any part of the figures or hieroglyphics be in intaglio or elaborately worked, it is better to press the paper over that part with the finger. Five minutes is quite sufficient time to make a cast of this description; when taken off the wall, it should be laid on the ground or sand to dry.

COMPOSITION ORNAMENTS FOR PICTURE FRAMES. — *Mixing.* — The principal ingredients are glue, water, linseed oil, rosin, and whiting, which are combined in such proportions as to make a mixture soft enough for working, while,

at the same time, it should be so tough as not to crack, and should harden in a few hours if the ornament be thin, or in a day or two if it be more massive. The state in which it is used by the ornament maker is that of a stiff dough; and the making of it resembles the process by which the baker makes his dough. The proper amount of glue is steeped in water, which is heated to dissolve the glue; while the oil and rosin are melted in a separate vessel, and then poured into the vessel containing the melted glue. The whiting is pounded, and placed in a tub or pan—being previously warmed if the weather be damp and cold—and the hot melted glue, oil, and rosin is poured upon the whiting, and then well mixed up with it, and kneaded, rolled, and beat, until it becomes a smooth, tough, elastic kind of dough or putty. It may then either be used at once, or may be laid aside for future use; but, whenever it is used, it must be warmed, either before a fire or by admitting steam to act upon it, because, when cold, it is too hard and stiff for use.

Moulding.—The manner of using this composition is to press it into moulds; the preparation of which is the most important part of the business: it is generally done by men who are not engaged in making the ornaments themselves. The moulds are usually made of boxwood, which, by its smoothness of grain, admits very fine figures to be cut in it, and is very durable. The mould carver has to proceed with his work in an opposite way to the ordinary carver; for he must make depressions or hollows instead of raised projections, and projections instead of hollows. The mould carver makes his mould look, in every part, directly the reverse of what he wishes the ornament to appear.

Carved Moulds.—The block of wood being planed and smoothed, the carver draws on its surface a representation of the object which he wishes to carve, and then proceeds to work out the minute details. The tools used in this carving are exceedingly fine and sharp, some of them not exceeding one-twentieth of an inch in width. These are, as in common carving, mostly gouges, with various degrees of curvature. The sharpening of them is a matter of great nicety, and in some cases requires files made of very fine wire. The block of boxwood is moistened with oil during the process of cutting, in order to facilitate the progress of the tool. The cuts are, in the first instance, made perpendicularly from the surface of the wood, and afterwards varied into the necessary directions to produce the pattern. In order to know how to vary the depth of different parts of the mould, the carver must either be guided by the accuracy of his eye and the correctness of his taste, or he must have another mould of the same pattern before him.

Cast Moulds.—Sometimes moulds are made by casting, the material being brass, copper, pewter, lead, or sulphur. A model, representing the object which it is desired to produce, is made of composition or plaster, and is placed on a flat stone, and surrounded by a raised border or edging, so that it lies in a cell or trough. The model is then oiled, and the melted metal or sulphur is poured on it, so as to entirely cover it. When cold, the raised border is broken away, the mould taken up, and the model removed from within it. It is then imbedded in a wooden case to preserve it from injury, and to fit it for the better reception of the composition. Sometimes brass moulds are made in this way, and afterwards chased; that is, the minuter details of ornament are cut, or rather scratched, by very fine tools. When the mould, whether of wood, metal, or sulphur, is to be employed to cast ornaments, it is brushed over with oil, to prevent the adhesion of the composition. A piece of composition, large enough for the intended purpose, is then taken up in a warm soft state, and pressed into the mould by the hand. A wet board is laid upon the surface of the composition, and the whole is put into a powerful screw-press, by which the composition is pressed into every part of the mould, however deep and minute it may be. The same pressure makes the upper surface of the composition

adhere to the wetted board, so that, when it is taken out of the press, the mould may be pulled off the ornament, leaving the latter adhering to the board. When the cast has become a little hardened, it is cut, or rather sliced off, with a broad knife, to the required thickness.

Fixing.—The composition ornament, thus made, is exceedingly pliant and supple, and may be bent into almost any form without breaking or injuring it: it is this property which makes these ornaments so convenient; as they may be applied to the round, the flat, or the hollow parts of a frame, with almost equal ease. They are fixed on either with glue, or, if quite soft and warm, with hot water, which, by softening the glue contained in the composition, produces a sufficiently strong cement; and, in a short time, they become sufficiently firm and hard to be handled without injury. In modern frames which are intended to imitate antique carved frames, the manner of laying on the various pieces of ornament requires much care in the workman. If an antique frame, or a drawing from it, is given to the ornament maker to imitate, he must have moulds carved of all the various parts, so that, when united on the frame, the assemblage of composition casts may present a facsimile of the frame. If he wishes to produce a frame which shall possess a general resemblance to old patterns, but without tying himself down to any individual pattern, he has to depend on his taste and judgment, both in the cutting of moulds and in the disposition of the various pieces of ornament on a frame. This composition, being a compact substance, is heavy. In this point carved ornaments have a great superiority over composition; indeed, the heaviness of the latter was one reason which led to the adoption of papier-mâché ornaments. When papier-mâché ornaments are used, they are cast in moulds, resembling those just described. The paper is in the state of a pulp; but there is this difference between the two kinds of ornaments. The pulp is pressed between two moulds, so that the thickness of the ornaments is seldom more than about a quarter of an inch at any part; thus the ornament is of less weight, and there is a saving of material.

To Make a Thermometer.—Take a fine glass tube blown into a bulb at one end. The bulb is heated, the air expands; it is then placed under mercury, which rushes in as the tube cools, and takes the place of the air which was driven out by the heat. It is then managed so that the mercury should be at a convenient spot at the common temperature. Apply heat to the mercury until the column rises quite to the top of the tube; then seal it by applying heat, the mercury on cooling leaves a vacuum, which is essential to the perfection of the instrument. The great point is to graduate it. The freezing-point of water or the melting-point of ice is always constant; the boiling-point of water is also constant. The barometric pressure being constant, distilled water is made to boil, and the thermometer surrounded with the steam produced; the point to which the mercury rises is marked off with a file, and the freezing-point of water is also marked. It only remains to divide the interval into degrees, which is arbitrary. In England Fahrenheit is used, the space between freezing and boiling being divided into 180, 32 being the freezing, and 212 the boiling-point. Zero is 32° below freezing point. In the Centigrade the interval is divided into 100. Zero is the freezing-point, and 100° the boiling-point. In Reaumur's scale the interval is divided into 80. Zero is again the freezing-point, whilst 80° is the boiling-point. To change Centigrade into Fahrenheit, multiply by 9, divide by 5, and add 32. To change Fahrenheit into Centigrade, subtract 32, multiply by 5, and divide by 9. To convert the degrees of Reaumur into Fahrenheit, multiply those of Reaumur by 9, divide by 4, and add 32; the sum will be the degrees on the scale of Fahrenheit. Spirit thermometers are the best where great cold is required, inasmuch as they are difficult to freeze. Mercury is best for high temperatures.

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